ANCIENT INDIAN CHRONOLOGY

ILLUSTRATING
SOME OF THE MOST IMPORTANT
ASTRONOMICAL METHODS

BY

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PREFACE

I published in the Journal of the Royal Asiatic Society of Bengal, Letters, in the years 1938 and 1939, the following five papers :—

(*i*) Some Astronomical References from the Mahābhārata and their Significance in Vol II , No. 10.

(*ii*) Bhārata-Battle Traditions. (*iii*) Solstice Days in Vedic Literature. (*iv*) Madhu-vidyā or the Science of Spring. (*v*) When Indra became Maghavān.	Published in Vol. IV, Nos. 15-18

The last four of the above papers were kindly communicated to the Royal Asiatic Society of Bengal by Prof. M. N. Saha, F.R.S., who had found in these papers methods and results in Ancient Indian Chronology which deserved encouragement. It was at his suggestion that I submitted to the authorities of the Calcutta University, in a letter dated the 23rd August, 1939, a scheme for publication of a research work on Indian Chronology. The University very kindly sanctioned my scheme in their Minutes of the Syndicate, dated the 30th September, 1939, and appointed Mr. Nirmalchandra Lahiri, M.A., to assist me in my research work. Under the very favourable conditions thus created by the University I took up work under the scheme from Nov., 1939, which was finished by July, 1941 in the form of the present work named "Ancient Indian Chronology."

The five papers mentioned above formed the nucleus of the present work. The last four of the above-named papers were noticed in the famous British Science Journal, "Nature" in Vol. 145, Jan., 6, 1940, in the Section of "Research Items," under the caption, "Some Indian Origins on the light of Astronomical Evidence" which is quoted at the end of this work.

I have carried on the researches embodied in the present work in the spirit of a sincere truth seeker. If I have been led by any bias my critics will kindly correct me and point

out the same to me. I have not hesitated to reject some of my former findings when further study and new light received therefrom justified such action. I trust my work will be continued by other Indian researchers in the same line in future.

I have to acknowledge my indebtedness to the works of the late Prof. Jacobi[1], Tilak[2] and Dīkṣita[3] on Vedic Chronology. To the works of Tilak and Dīkṣita I am indebted for many references from the Vedas, but in many cases my interpretation has been different from theirs.

I have also to acknowledge with thanks the sympathy and help with which I was received by Mm. Vidhuśekhara Śāstrī, late Asutosh Professor of Sanskrit, Calcutta University and his colleague Mm. Sītārāma Śāstrī, whenever I approached them as to the correct interpretation of Vedic passages. To Prof. Dr. M. N. Saha, F.R.S., I am indebted for constant encouragement and help in the matter of making many books accessible to me and for many helpful discusssions and criticisms. I have to express my thanks to the authorities of the Calcutta University, and specially to Dr. Syamaprasad Mookerjee, M.A., B.L., D.Litt., Bar.-at-Law, M.L.A., late President of the Council of Post-Graduate Teaching in Arts, for creating this facility for me to carry on my researches.

Finally I have to pay my tribute of respect to the memory of the late Sir Asutosh Mookerjee, the inspirer and organiser of research studies at the Calcutta University, and of the late Maharaja Sir Manindrachandra Nandi, K.C.I.E., of Cossimbazar, the donor of the fund created for Research work in Indian Astronomy, from which was met the major expenses in carrying out the researches.

Calcutta, October, 1947. P. C. SENGUPTA.

1 "On the Date of the Ṛgveda"—Indian Antiquary, Vol. xxiii, pp. 154-159.

INTRODUCTION

The word 'chronology' meant apparent dating only, from the 16th century of the Christian era. The word has now come to mean 'the science of computing and adjusting time and periods of time, and also of recording and arranging events in order of time; it means computation of time and assignation of events to their correct dates.''[1] In the present work, it is the science of Astronomy alone that has been brought into requisition in ascertaining the dates of past history of the Hindus, both of the Vedic and of later times. The data for dates arrived at from 4170 B.C. to 625 B.C. have been derived from the sources which are either of the Vedic or post-Vedic Sanskrit literature. In the section on the Indian eras, they have been derived chiefly from the archaeological sources.

Now, chronology is based on the interpretation that we may put to any statement which is derived either from the literary or epigraphic sources. Whether the interpretations accepted in the present work are justifiable, is a point that is to be decided by the author's critics. So far as he is concerned he has this satisfaction that he could not find any better interpretations than what he has accepted of the astronomical references which he could discover and use for the present work. It is made up of the following sections, *viz.*, the Date of Bhārata Battle, the Vedic Antiquity, Brāhmaṇa Chronology, and on the Indian Eras. It has not been possible to ascertain any dates from any other *Śrauta Sūtras* excepting those of

Baudhāyana, Kātyāyana and Āpastamba. The *Gṛhya Sūtras* do not present any new indication of dates.

The results of the findings may be briefly stated thus :— The date of the Bhārata Battle has been proved to have been the year 2449 B.C., so far as evidences can be discovered from the Sanskrit literature, no other date for the event is now possible. The antiquity of the Ṛgveda as shown in the chapters of the book extend from 4000 B.C. to perhaps 2450 B.C. The Atharva Veda indications also point to dates from 4000 B.C. to about 2350 B.C., *viz.*, the time of Janamejaya Pārikṣita, while the different sections of the Yajur-veda show a range of dates beginning from about 2450 B.C.

As to the *Brāhmaṇas* and *Śrauta Sūtras*, they are books on rituals only and as such they cannot belong to the same antiquity as the Vedas themselves, more specially the Ṛg-veda. The range of dates obtained for this type of works extends from about 1625 B.C. to about 630 B.C. So far as my studies go, the *Yajurveda* itself is more or less a *Brāhmaṇa* or a work on rituals. The *Brāhmaṇas* as a rule record the traditional days for beginning the sacrifices which indicate the earliest date of about 3550 B.C. Such statements, however, cannot give us the dates of the *Brāhmaṇas* which record them.

The *Śrauta Sūtras* generally are crude followers of earlier rules as to the beginning of the year, the same remarks are applicable to all the *Gṛhya Sūtras*. The *Jyautiṣa Vedāṅgas* indicate a date of about 1400 B.C. In the section of the Indian Eras, it has been shown that the Buddha's Nirvāṇa era should be dated at 544 B.C., if the eclipses spoken of in the *Saṁyukta Nikāya* can be held as real events happening in the Buddha's life time. It has also been shown that the zero year of the early Kharoṣṭhī inscriptions, should be taken as the year 305 B.C., the era itself may be called that of Selukus Nikator ; the zero year

of the later Kharoṣṭhī inscriptions or of Kaniska's era was 80 A.D.; while of the current Śaka era the Zero year is 77-78 A.D. It has been shown in the chapter on the *Saṁvat* or Mālava era, that it was started from 57 B.C. which is reckoned as the year 1 of this era. An attempt has been made to show why the years of this era are called Kṛta years. The Zero year of the Gupta era should definitely be taken as the year 319 A.D. or 319-20 A.D., or the Śaka year 241 as recorded by Alberūnī. The date of Kālidāsa has been ascertained as the middle of the sixth century of the Christian era. The modern *Rāmāyaṇa* may be dated about a hundred years earlier than the time of Kālidāsa.

One point that I specially want to emphasise is this:—The date of a book may be much later than the date of an event which it records. The Rāma story is certainly much older than the time of the Pāṇḍavas, but the modern work *Rāmāyaṇa* cannot be dated earlier than about 450 A.D. The date of the Bhārata Battle is 2449 B.C., but the book, the present *Mahābhārata* must be dated about 400-300 B.C. The Vedic antiquity runs up to 4000 B.C., but the date when the Ṛgveda was written in the form in which we get it now, must be dated much later. To ascertain this later date is perhaps not possible. The points to be settled are (1) When did the present highly scientific Indian alphabet come into being? (2) What alphabet was in use amongst the Hindus for recording their Vedic songs and other literature? (3) What were the earliest vocal forms of the words used in the Vedas? We therefore conclude that the antiquity of the Vedic culture is one thing while the date of the present Ṛgveda is another, the date of the Bhārata Battle is one thing while the date of the modern Mahābhārata is another, the date of Rāma or the Rāma story is one thing while the date of the modern Rāmāyaṇa, is another. The

sūktas or hymns in the Ṛg-Veda, M. X, 30-34. All these considerations lead us to conclude that the latest portions of the Ṛg-Veda were composed at the time of the Pāṇḍavas (2449 B.C.), when according to tradition the Vedas were subdivided into *Ṛk, Sāma* ahd *Yajus,* and the author of this division was Vyäsa the common ancestor of the Kauravas and the Pāṇḍavas. The *Atharva Veda,* in my opinion, records traditions which are as old as of the Ṛg-Veda itself, as may be seen from Chapters VIII, X and XI. As this *Veda* (*Atharva*) says **अयनं मघासि**[1] or "that the (southerly) course is at the *Maghās* in my time" and **जनः स भद्रमेधति राष्ट्रे राज्ञः परिक्षितः**[2] or "that man prospers well in the kingdom of Pariksita," I understand that the time indicated is between 2449 to 2350 B.C. Thus according to the evidences cited above, the Atharva Veda also was completed about the time of the Pāṇḍavas.

Vedic Antiquity and the Indus Valley civilisation

In the Ṛg-Veda we get the following references to the *Śiśnadevas*:—

(*a*) M. VII, 21, 5 :—

न या तवऽइन्द्र जुजुर्नो न वन्दना शविष्ठ वेद्याभिः ।
स शर्धदर्यो विषुणस्य जन्तोर्मा शिश्नदेवाऽअपि गुर्ऋतं नः ॥

"Let not the Rākṣasas, Indra, do us harm: let not the evil spirits do harm to our progeny, most powerful Indra; let the sovereign lord (Indra), exert himself (in the restraint of) disorderly beings, so that the unchaste (*Śiśnadevas*) may not disturb our rite." (Wilson)

(*b*) M. X, 99, 3 :—

स वाजंयातापदुष्पदा यन्त्स्वर्षातापरिषदत् सनिष्यन् ।
अनर्वायच्छतदुरस्य वेदो घ्नन्शिश्नदेवाँऽअभिवर्पसाभूत् ॥

"Going to the battle, marching with easy gait, desiring the spoil, he set himself to the acquisition of all wealth. Invincible, destroying the Phallus-worshippers (शिश्नदेवान्), he won by his prowess whatever wealth (was concealed) in the city with hundred gates." (Wilson)

It appears that these Phallic-worshippers were a rich people living in large cities, which were raided by the worshippers of Indra and other Vedic gods and carried away a rich booty. These *Śiśnadevas* were probably the same who founded the cities of Mohenjodaro and Harappa and lived also in the land of the seven rivers (the Punjab).

In the *Mahābhārata* again we have many references which show that *Rākṣasas*, the *Asuras* and the Aryan Hindus had their Kingdoms side by side. In the *Vana parva* or the Book III of the *Mahābhārata*, Chapters 13-22 give us a description of the destruction of the *Śaubha Purī* by Kṛṣṇa. This may mean the destruction of a city like Mohenjo-daro. I mention the above references with which I came across in my chronological survey of the Vedas and the Mahābhārata. They have been noticed by others before me, but furnish no data for any chronological finding by astronomical methods.

Date of Rāma or Rāma Story

In the present work it has been ascertained that the date of the Bhārata battle is 2449 B.C. It may now be asked "is it possible to find the time of Rāma astronomically?" The answer I have to give is a definite "no." If the Purāṇic dynastic lists may at all be thought reliable, in the *Vāyu Purāṇa* (chapter 88), we have, between Rāma and Bṛhadvala, a reckoning of 28 generations till the Bhārata battle, and the *Matsya Purāṇa* (chapter 12) records 14 generations only, while the *Viṣṇu Purāṇa* records 33 generations between Rāma and Bṛhadvala. If we put any faith in the

Vāyu list the time of Rāma becomes about 700 years prior to the date of the Bhārata battle, *i.e.*, about 3150 B.C.

It may be asked why have I not attacked the problem of finding Rāma's time from the horoscope of his birth time given in the modern *Rāmâyaṇa* ? The problem was dealt with before me by Bentley in the year 1823 A.D. and his finding is that Rāma was born on the 6th of April, 961 B.C.[1]—a result which is totally unreliable.

(1) The 12 signs of the Zodiac spoken of in the *Rāmāyaṇa* in this connection, were not introduced in Indian astronomy before 400 A.D.

(2) The places of exaltation of the planets were settled only when the *Yavana* astrology came to India of which also the date can hardly be prior to 400 A.D.

(3) Bentley's finding also does not give us the positions of Jupiter and Mars as stated in the *Rāmāyaṇa* reference.

(4) The *Rāmāyaṇa* statement of Rāma's horoscope is inconsistent in itself. Five planets cannot be in their places of exaltation under the circumstances mentioned therein, as the sun cannot be assumed to have been in the sign *Aries*. This ought to be clear to any astrologer of the present time.

(5) Bentley has not established a cycle for the repetition of the celestial positions, or has not even shown that his was a unique finding. Even then, as stated before, his finding is not satisfactory, and admitted as such by himself.

(6) Further the discovery in India of the seven 'planets' could not have taken place within the truly Vedic period, *i.e.*, from 4000 B.C. to 2500 B.C.

[1] Bentley's Hindu Astronomy, page 13. L. D. Swami Kannu Pillai in his work "An Indian Ephemeris," pp. 112-120, having assumed that in Rāma's horoscope, the sun was in Aries, moon in Taurus, Mars in Capricorn, Jupiter in Cancer and Saturn in Libra, arrived at the year 964 B.C., and the date as March 31 of the year. This is also impossible as calculations are based on the S. Siddhanta. He also believes that Rāma's horoscope was unreal.

In the Vedic time only four of the 'planets' were discovered, *viz.*, the sun, moon, Jupiter and also perhaps Venus. The planet Venus was very probably known by the names Venā,[1] Vena [2] or the Daughter of Sun (*i.e.*, सूर्यस्य दुहिता [3] or सूर्या [4]) who was married to Moon, and the Aśvins carried her in their own car to the groom. At the time of the Bhārata battle, however, we find that Saturn was discovered and named but confounded with Jupiter. Mars is called a 'cruel planet' but not given a name. Even Mercury is named as the "son of Moon." (*vide* pages 30-32). When in later times [5] (*i.e.*, later than 400 A.D., probably), the sacrifices to the 'nine planets' were instituted, the appropriate verses selected for offering libations to these 'planets' were *ṛcas* (1) "आ कृष्णेन, etc.", for the sacrifice to the sun from the Ṛgveda, (2) "आप्यायस्व, etc.", for the sacrifice to the moon and it is sacred to the moon or soma, (3) "अग्निर्मूर्धा दिवः, etc.", for Mars, which is sacred to Agni or fire-god, (4) "अग्नेर्विवस्वदुषसः, etc.", for Mercury, which is also sacred to Agni, (5) "बृहस्पते परिदीया रथेन, etc.", for Jupiter which is sacred to Jupiter, (6) शुक्रं ते अन्यत्, etc.", for oblations to Venus and this is sacred to *Pūṣan*, (7) "शन्नो देवी, etc.", for oblations to saturn, but the *ṛc* itself is sacred to the water goddess, (8) "कया नश्चित्र, etc.", for oblations to the ascending node, and which is sacred to Indra and (9) "केतुं कृण्वन् for the descending node's oblation and is also sacred to Indra. It is thus clear that the appropriate *ṛcas* for oblations to Sun, Moon and Jupiter only could be found from the Vedas: as to the rest of the 'planets' the suitable *ṛcas* for offering oblations to them, could not be found out from the same source.

Thus in the truly Vedic period there is no evidence forthcoming which would show that the 'planets Mercury, Mars, Saturn and the Moon's nodes were discovered.' Late

[1] M. I, 14, 2. [2] M. X. 8-23, 1. [3] M. I, 116, 17.
[4] X. 47, 3.13 [5] Matsya Purāṇa, Chapter 93

Mr. S. B. Dikshita's finding on this point is also the same as mine and the reader is referred to his great work भारतीय ज्योतिःशास्त्र, pp. 63-66. (1st Edn.).

Hence the conclusion is inevitable that when we meet with a statement like the above as to the horoscope of the birth time of Rāma or of Kṛṣṇa, we can never believe it. It is a mere waste of energy to try to find the date of birth of Rāma or of Kṛṣṇa from such a statement, which is tantamount to saying that "whenever a great man is born four or five planets must be in their exalted positions." In scientific Chronology such "poeto-astrological effusions" cannot have any place.

If we want to find the time of Rāma or of Kṛṣṇa, we have to depend on a well established date of the Bhārata battle, and then from *Purāṇic* or other evidences try to find these times. We have already said that if the *Purāṇic* dynastic list can be believed, the time of Rāma should be about 3150 B.C.

Date of Kṛṣṇa's Birth

Similarly if we believe in the statement that Kṛṣṇa was born on the last quarter of Śrāvaṇa, on which the moon was conjoined with the *Rohiṇī* (*Aldebaran*), [1] then using the further condition that the Bhārata battle was fought in 2449 B.C., we can show that Kṛṣṇa was born on July 21, 2501 B. C. For on this day at G. M. N. or 5-8 P.M. Kurukṣetra mean time :—

Mean Sun = 98°21′49″	Thus—
,, Moon = 359°51′16″	Apparent Sun = 96°23′
Lunar Perigee = 222°31′53″	,, Moon = 4°50′
A. Node = 33°52′44″	*Aldebaran* = 7°33′
Sun's Apogee = 26°10′ 48″	
Sun's eccentricity = ·01834612	

1 अष्टमी रोहिणीयुक्ता निशार्धे दृश्यते यदि ।
मुख्यकालः स विज्ञेयो यत्र जातो हरिः स्वयम् ॥

The moon was conjoined with *Aldebaran* about 10-34 P.M. Kurukṣetra mean time, the moon had a south latitude 2°30′ and Aldebaran's south latitude was 5°28′. The moon and Aldebaran were separated by about 3° only. Thus at midnight the conjunction of Moon with Rohiṇī (*Aldebaran*), was a beautiful phenomenon to observe.

If, however, we pin any faith in the following statement as to the horoscope of Kṛṣṇa's birth-time as it is given in a work on *Jyotiṣa* (Astrology) named खमाणिक्य :—

उच्चस्थाः शशिभौमचान्द्रिशनयोः लग्नं वृषो लाभगो जीवः ।
सिंहतुलालिषु क्रमवशात् पूषोशनोराहवः ॥
नैशिथः समयोऽष्टमी बुधदिनं ब्रह्मर्क्षमत्र क्षणे ।
श्रीकृष्णाभिधमम्बुजेक्षणमभूदाविः परं ब्रह्म तत् ॥

"In the places of exaltation were the moon, Mars, Mercury and Saturn, the ascendant was in the sign Taurus and Jupiter was in the place called *lābha* (*i.e.*, लाभ, the eleventh house, the sign *Pisces*); in the signs Leo, Libra and Scorpion were respectively the Sun, Venus and the Node; it was midnight and the day of the 8th *tithi* on a Wednesday, and the moon's *nakṣatra* was *Rohiṇī*—it was at this instant that the lotus-eyed person named Śrīkṛṣṇa was born, and that was the great Brahman itself."—We readily recognise that this statement was a pure invention by an astrologer of times much later than 400 A.D.

Bentley attempted a solution of this problem of finding date of Kṛṣṇa's birth from the above data and was led to the date 7th August, 600 A.D.[1] But here as in the case of Rāma's horoscope, he did not find the astronomical cycle in which this position of planets and the day of the week repeat themselves.

First of all there can be no question of the existence of the 12 signs of the Zodiac in Kṛṣṇa's time, secondly, the reckoning of the days of the week did not come into vogue

[1] Bentley's Hindu Astronomy, page, 91.

in India much before 484 A.D.[1] Thirdly the assignment of the houses of exaltation to the different planets cannot be prior to 400 A.D. The statements of the type quoted above are pure astrological concoctions, having absolutely no chronological bearing.

Vedic Ritual Literature

On this head we have (1) the *Brāhmaṇas*, (2) the *Srauta Sūtras*, (3) *Gṛhya Sūtras* and (4) the *Vedāṁgas*. These works cannot be of the same antiquity as the Vedas.

As to the Brāhmaṇas, they almost all were completed after the time of Janamejaya Pārikṣita, without any shade of doubt; the Aitareya,[2] Śatapatha[3] and the Gopatha[4] Brahmaṇas speak of the Aśvamedha sacrifices performed by this prince. From what has been shown before *Janamejaya Pārikṣita's* time should be about 2413-2389 B.C. as Parikṣit lived up to the age of 60 years and was crowned king, 36 years after the Bhārata battle. The oldest traditional solstice days as recorded in the Brāhmaṇas are such as indicate an antiquity of 3550 B.C., and that the *Yajurveda* was completed about the time of the Pāṇḍavas *i.e.*, 2449 B.C.[1] The oldest tradition about the winter solstice day was the full-moon day of *Phālguna*, the next tradition about the winter solstice day was the new-moon day of *Māgha*. In later times the day of full-moon of *Phālguna* came to mean the beginning of spring as in the *Śatapatha* and the *Taittirīya Brāhmaṇas*. The date when this was the case has been shown as 756 B.C. as the superior limit. According to the finding in the present work, the date of the *Jaiminīya Brāhmaṇa* has come out as about 1625 B.C., the *Sāṁkhyāyana Brāhmaṇa* (as distinctly separate from the *Kausītaki Brāhmaṇa*, which has

not been brought to light yet) as about 1000 B.C. the Vedāṅgas about 1400 B.C., the *Baudhāyana Śrauta Sūtras* as about 900 B.C., the *Āpastamba* and *Kātyāyana Śrauta Sūtras* about 625 B.C. These will be found detailed in Chapters XV to XX.

In the present work, it has been shown[1] that the Vedic Hindus could find accurately the winter or the summer solstice day. For this the observation of the sun's amplitude at sunrise most probably used to be begun before the dawn. With this method came the invariable concomitant of the observation of the heliacal rising of prominent stars at the beginning of the different seasons. Thus in the earliest Vedic times, the heliacal risings of the *Aśvins* was found as the beginning of spring, and that of the *Maghās* as the beginning of the rains.[2] Some centuries later the heliacal rising of λ *Scorpionis* was used as a mark for the beginning of the Indian season of Dews (*i.e.*, *Hemanta*). The *Jaiminīya* and the *Tāṇḍya Brāhmaṇas* speak of the heliacal rising of the *Delphinis* cluster on the winter solstice day and the *Śāṁkhāyana* Brāhmaṇa of the heliacal rising of *Pollux*, at the middle of the year or the summer solstice day. In the present work I have generally avoided the use of statements like—"Kṛttikās do not swerve from the east"[3] or that the *Aśvins* were indicative of a direction.[4] There are many things to be considered in this connection: (1) whether the statements mean the true eastward direction, (2) at what altitude did the *Kṛttikās* or *Aśvins* show the eastward direction. (3) what was the latitude of the observer. It is of course easy to see that η *Tauri* the chief star of the *Kṛttikās* and α *Arietis* of the *Aśvins*, had their

[1] Chapter XIII. In the reference quoted in this chapter the method of the *Brāhmaṇa* refers directly to the summer solstice day, on which the gods raised up the sun to the highest limit on the meridian.

[2] *Vide* Chapters IV V.

[3] *Śatapatha Brāhmaṇa*, II, 1, 2, 3.

[4] Ṛgveda. M. I. 116, 3-5.

declinations=Zero, respectively at 3000 B.C. and 2350 B.C. very nearly ; but these statements cannot yield a solution of the chronological question involved.

In the section of this work on the Indian Eras, the main results have been already stated. One point of very great importance has been brought to light in the Chapter XXV, on the Gupta era. The Indian years before the time of Āryabhaṭa I, were generally begun from the winter solstice day, but after his time gradually the years came to be reckoned from the vernal equinoctial day. In the Gupta era, the years were originally of *Pauṣa Śuklādi* reckoning, but after the year 499 A.D., some year of this era which was different in different localities, began the *Caitra Śukla* reckoning. Thus one year was a "year of confusion" in Indian calendar which consisted of 15 or 16 lunations. The *Caitra Śuklādi* reckoning was thus a creation of Āryabhaṭa I, and all works which show *Caitra Śuklādi* reckoning cannot be dated earlier than 499 A.D.

Limitations to the Astronomical Determination of Past dates.

In finding the date of the Bhārata Battle, the data evolved from the *Mahābhārata* were really—(1) that the year in our own times similar in respect of luni-solar-steller aspects to the year of the battle, was the year 1929 A.D. and (2) that the day on which the sun turned north in the year of the battle corresponded in our time to Feb. 19, 1930 A.D. From these data it was quite possible to arrive at the year 2449 B.C. as the year of the battle, but still we could not be sure that this was the real year of the battle unless there was a tradition to support this finding. From a strictly astronomical view point the year arrived at might be raised or lowered by one or two multiples of the 19 year cycle. Here the astronomical finding got a corroboration

Similarly we could not be sure that the antiquity of the Vedic culture is to be dated about 4000 B.C., unless we had another event of the solar eclipse as described in the Ṛg-Veda—which according to my interpretation happened in 3928 B.C., on the 26th July—the summer solstice day. Here also we have got other traditional evidences from the Vedas (specially from the *Atharva-Veda*) and also from our calendar on the date for the hoisting of Indra's Flag.[1]

In Chapter XVIII on the time references from the *Baudhāyana Śrauta Sūtra*, according to the data which I could evolve from this work on the position of the solstices and from the rules for beginning the *Nakṣatreṣṭi*, *Pañca-śāradīya*, and the *Rājasūya* sacrifices, the date has come out to have been 887-86 B.C. If the position of the solstices as indicated in the work and as understood by me is only approximate, the date may be raised or lowered by some luni-solar cycle in tropical years. If this work, the *Baudhāyana* had in addition an account of a solar eclipse on a fixed day of the year, we could absolutely fix the date. It was thus possible to fix a mean date only, for the time when the data evolved were astronomically correct.

Speaking generally, an astronomically determined past date from luni-solar data can hardly be absolutely correct, when it is further recalled that there might be errors of observation. Lastly we have to settle whether what we get as the date ascertained is to be taken as the date of the work or the date of the tradition. Astronomy therefore can only give certain landmarks, as it were, in ancient Indian Chronology, some of which should be subjected to critical examination by epigraphic and other scientific methods that may be discovered and applied to test the findings in this work.

Astronomical Constants used

So far as the astronomical calculations and the findings are concerned, I trust that they are correct to the degree of

accuracy aimed at, as in this work the most up-to-date astronomical constants have been used throughout. They are for the epoch Greenwich mean noon on January 1, 1900 A.D. and t stands for Julian centuries elapsed from the epoch. Here

L denotes the mean longitude of a planet
ω ,, ,, longitude of its perigee or perihelition
e ,, ,, eccentricity of the orbit
θ ,, ,, longitude of the ascending node of the orbit.

(*a*) For the sun's mean elements :—

$$L = 280°40' \, 56''\cdot37 + 129602768''\cdot13t + 1''\cdot089t^2$$
$$\omega = 281° \, 13' \, 15''\cdot17 + 6189''\cdot03t + 1''\cdot63t^2 + 0''\cdot012t^3$$
$$e = 0\cdot01675104 - 0\cdot00004180t - 0\cdot000000126t^2$$

(Newcomb)

(*b*) For the moon's mean elements :—

$$a = 283°36' \, 46''\cdot74 + 17'32564406''\cdot06t + 7''\cdot14t^2 + 0''\cdot0068t^3$$
$$\omega = 334°26' \, 27''\cdot45 + 14648522\cdot52t - 37''\cdot17t^2 - 0''\cdot045t^3$$
$$\theta = 259° \, 7' \, 49\cdot16 - 6962911''\cdot23t + 7''\cdot48t^2 + 0''\cdot008t^3$$

(Brown)

(*c*) For Jupiter's mean elements :

$$L = 238° \, 7' \, 56''\cdot59 + 10930687''\cdot148t + 1''\cdot20486t^2 - 0''\cdot005926t^3$$
$$\omega = 12°43' \, 15''\cdot50 + 5795''\cdot862t + 3\cdot80258t^2 - 0\cdot01236t^3$$
$$e = 0\cdot04833475 + 0\cdot000164180t - 0''\cdot0000004676t^2 - 0\cdot0000000017t^3$$

(Leverrier and Gaillot)

For the mean elements of Mercury, Venus and Mars, Newcomb's and Ross's equations have been used, while those for Saturn, the equations used are of Leverrier and

For finding the apparent places of the sun, only the equation of apsis has been applied, and for the apparent places of the moon only 4 or 5 of the principal equations have been applied generally. In the case of the solar eclipses, the mean place of the moon has been corrected by a maximum of 15 equations. The planetary perturbations have not been considered.

Methods of chronology employed

The methods of chronology employed in the present work will, I hope, be readily understood by scholars who are interested in this new science. In this general introduction it seems rather out of place to detail them. These methods have developed in me as the necessity for them was felt. Those of my readers who feel any special interest for them, will find them fully illustrated throughout this work and I would specially refer them to the sections on the Date of the Bhārata battle and on the Vedic Antiquity. I cannot persuade myself to think that I am the first to discover them. In outline they are :

(1) Employment of the luni-solar cycles of 3, 8, 19, 160 and 1939 sidereal years[1] as established in this work.

(2) Methods of backward calculation of planetary elements from Jan. 1, 1900 A.D., G. M. Noon.

(3) Method of finding the past time when two selected stars had the same right ascension (where possible).

(4) Method of finding an eclipse of the sun in any past age which happened on a given day of the tropical year. The eclipse-cycles established are of :—

456, 391, 763 tropical years and others derived from them.[2]

[1] The luni-solar cycles in tropical years will be found in Chapter IX on the

For finding a solar eclipse near to a past date I have also found the following cycles in the way in which the Babylonian *Saros* is established in astronomical text books.

They are :—

(1) 18 Julian years + 10·5 days (the Chaldean *Saros*.)
(2) 57 Julian years + 324·75 days.
(3) 307 Julian years + 173·25 days.
(4) 365 Julian years + 132·75 days.
(5) 1768 Julian years + 338 days.

In terms of civil days these cycles are respectively of 6585, 21144, 12305, 133449 and 646100 days.

These may prove useful to future researchers in chronology, besides the ones stated before.

For facilitating calculations according to the *Indian Siddhāntas*, the following equations true for the *Ardharātrika* system, will be found very useful :—

(*a*) *Sūrya Siddhānta Ahargaṇa* (from "creation") = Julian days + 714401708162.

(*b*) *Kali Ahargaṇa* + 588465 = Julian days.

(*c*) *Khaṇḍakhādyaka Ahargaṇa* + 1964030 = Julian days.

The luni-solar cycles according to the constants of the *Sūrya-siddhānta*, the *Khaṇḍakhādyaka* and the *Āryabhaṭīya* are the following :—

3, 8, 19, 122, 263, 385 and 648 Indian solar-years.

Mr. Nirmalchandra Lahiri, M.A., has worked as my research assistant during the preparation of this work, under the arrangement made by the Calcutta University as detailed in the preface. He has revised all my calculations, has made independent calculations according to my direction and has helped me occasionally with valuable suggestions.

I shall be grateful for any corrections and suggestions for the improvement of this work.

SPECIAL NOTE TO CHAPTER VI

In this work in finding the past dates by the heliacal risings of stars at different seasons, the author was under the impression that the Vedic Hindus were more concerned with the beginning of the dawn than with the actual heliacal rising of the star concerned. It is for this reason, that it has been assumed throughout, that the sun's depression below the horizon was 18°, when the star was observed near the horizon and not at the exact heliacal visibility, which might have happened some days earlier. On the other hand it may be held that in some cases at least the actual heliacal visibility itself should have been taken as the basis for the determination of the dates. This of course may be conceded. In the case of the brightest star, *viz.*, *Sirius* or *α Canis Majoris*, the correct depression of the sun below the horizon at its heliacal visibility should be about 10°. The Vedic people were perhaps not so very accurate in their observation. Hence in the case of this star, the sun's depression below the horizon should be taken at 12° and not 10° at its heliacal visibility. This would allow for the necessary altitude of the star above the horizon at the time of observation so that it might be easily recognised. This would also allow for the uncertainty of the horizon being clear for observation.

In view of the above consideration the finding of the date of Vāmadeva in Chapter VI, should be modified. Again Vāmadeva's statement that the Ṛbhus should awake since 12 days have elapsed in their period of sleep in the orb of the sun, may or may not be associated with the heliacal rising of the Dogstar as spoken of by Dīrghatamas. If this association is not allowable Vāmadeva's date cannot be found on this

basis. If this is allowed, it may be assumed that the summer solstice day was probably estimated from the correct determination of the winter solstice day.

It thus becomes necessary to determine by how many days did the estimated summer solstice day, precede the actual summer solstice day. It has been shown on page 108, that at about 2000 B.C. the sun's northerly course lasted for 186 days, while the Vedic people held that the two courses were of equal duration, each having a length of 183 days. The estimated summer solstice day would be 3 days before the actual summer solstice day. Hence Vāmadeva's statement of 12 days after the summer solstice day as estimated would mean a day 9 days after the summer solstice day. The sun's longitude should be taken about 99° and not 102° as used in Chapter VI. The sun's depression below the horizon should be 12°, and ω, the obliquity of the ecliptic at 2100 B.C. $=23°56'15''$.

Hence sun's right ascension $=99°49'52''$. the sun's declination $=23°27'30''$. It would follow that:—

(1) $\angle ZPS=120°58'9''$, (2) $\gamma E=68°51'43''$, (3) the angle $0=54°17'21''$, (4) $\gamma O=84°9'24''$, (5) $OL=36°28'22''$ and (6) $\gamma L=47°40'52''$ as shown and named in the figure in page 87. Sirius's mean longitude for 1931 being $103°8'$, the increase in the longitude of the star till 1931 becomes $55°27'$, which shows the date of Vāmadeva to be about 2100 B.C. This seems to be a result hardly acceptable. Vāmadeva in the Ṛgveda, M. IV, 15, in verses 7-10 invokes the fire-god Agni to bless the Kumāra *Sāhadevya* (son of Sahadeva) whose name is *Somaka*. According to the Purāṇas, Sahadeva, the son of Jarāsandha, was killed in the Bhārata battle, and his son, the grandson of Jarāsandha was *Somadhi*. If *Somaka* and *Somadhi* mean the same prince, the date of Vāmadeva should be about 2449 B.C., which is the date of

ascending [1] brilliant emblem of Agni (*i.e.*, Kṛttikās) as stationed on the east of the earth (M. IV. 5, 7). Assuming the star *Alcyone* of the *Kṛttikās* was seen at Rajgir (25°N) at and at an altitude of about 7°30′ (or 8° due to refraction) on the prime-vertical, the date comes out as *2444 B.C.* At this altitude also the swift ascending stage may be admitted. It is quite unintelligible, how Prof. Prey, from the same data assumed that the star was on the prime-vertical at an **altitude of 30°** and thus arrived at the date 1100 B.C. (Winternitz's History of Indian Literature, Vol. I, page 298).

The heliacal visibility of the star is really indicated by what *ṛṣi* Dīrghatamas says; we may therefore try to determine the date of Dīrghatamas. It is the tradition of N. India, that the cloudy sky persists for 3 days after the summer solstice day, the period being called *ambuvācī* or cloudy days. We therefore take the following data for the heliacal visibility of the Dogstar in Dīrghatamas's time :—

(*a*) Sun's longitude = 93°, (*b*) the sun's depression below the horizon at the heliacal visibility of the star = 12°, (*c*) the obliquity of the ecliptic = 24°1′ for 2900 B.C., (*d*) the latitude of the station, Kurukṣetra = 30°N.

Now the sun's right ascension = 93°17′, the sun's declination = 23°58′54″. We calculate as before—

(1) $\angle ZPS = 121°18'16''$, (2) $\gamma E = 61°58'44''$, (3) $\angle O = 51°29'$ (4) $\gamma 0 = 77°41'7''$, (5) $OL = 41°9'46''$ and (6) γL

[1] तमिन्न्वेव समना समानमभिक्रत्वा पुनती धीतिरश्याः ।
ससस्यचर्मन्नधिचारुपृश्नेरग्रे रुपऽआरुपितं जबारु ॥७॥

Translation :

" May our self-purifying praise, suited to his glory, and accompanied by worship, quickly attain to that omniform (*Vaiśvānara*) whose **swift ascending** brilliant (orb) is stationed on the east of the earth, to mount, like the sun, above the immovable heaven."

Here in place of " orb " as supplied by Wilson, the word should have been " emblem " *i.e.*, the *Kṛttikās* (*Pleiades*) of which the regent is the firegod *Vaiśvānara* or Agni. Hence is our astronomical interpretation, which is echoed in the *Śatapatha Brāhmaṇa*, *Kāṇḍa*, II, Ch., 1, 2-3, that the *Kṛttikās* do not swerve from the east.

$=36°31'21''$, (7) the increase in the longitude of Sirius till $1931=66°77'$ nearly. The date arrived at for Dīrghatamas becomes *2925 B.C.*

Now the date of the Bhārata battle as found in this work has been 2449 B.C. This *ṛṣi* Dīrghatamas was a contemporary of King Bharata of the lunar race according to the *Aitareya Brāhmaṇa.*[1] Between Bharata and Yudhiṣṭhira the dynastic list of the lunar race as given in the *Mahābhārata* (MBh., Ādi, Chapter 95), records 17 reign periods of princes of this dynasty. The interval between the dates stated above is 476 years, which divided by 17, makes the average length of a reign period = 28 years. Hence the historical method here corroborates the astronomical finding.

As to the remaining findings in this work on the basis of seasonal heliacal risings of stars, perhaps need no modification specially when the stars are ecliptic and also when they are of a magnitude less than the second.

[1] *Aitareya Brāhmaṇa*, Ch. 39, Khaṇḍa 9, 22.

एतेन ह वा ऐन्द्रेण महाभिषेकेण दीर्घतमा मामतेयो भरतं दौष्यन्तिमभिषिषेच तस्मादु भरतो दौष्यन्तिः समन्तं सर्वतः पृथिवीं जयन् परीयायाश्वैश्च मेध्यैरीजे ।

"By this Aindra great anointing, Dīrghatamas, the son of Mamatā, bathed the King Bharata, the son of Duṣyanta. By virtue of it Bharata, the son of Duṣyanta, conquered the whole world in all the quarters in his victorious expedition and also performed the Aśvamedha sacrifice"

Cf. also *Śatapatha Brāhmaṇa*, Ch. 13, 5, 4, 11-14. Weber's Edn., p. 995. Here no mention is made of the priest Dīrghatamas.

ANCIENT INDIAN CHRONOLOGY

CHAPTER I

DATE OF THE BHĀRATA BATTLE

Evidence from the Mahābhārata

The Bhārata battle is now generally believed to have been a real pre-historic past event. It is on this assumption that we propose to determine the date of this battle. Hitherto no epigrapic evidence leading to this date has been brought to light. Consequently we have to rely on our great epic the *Mahābhārata* and the *Purāṇas*. The description of the fight can be found only in the *Mahābhārata* while the *Purāṇas* definitely indicate that it was a real event. In this chapter we rely solely on the *Mahābhārata* astronomical references. The great epic *Mahābhārata* has had its development into the present form, from its earliest nucleus in the form of *gāthā nārāśaṁsīs, i.e.*, sagas or songs of heroes. In fact the *Mahābhārata* itself is *jaya* or a tale of victory, so also are the *Purāṇas*. The next stage in the development of the *Mahābhārata* was perhaps in the form of the works *Bhārata* and the *Mahābhārata* as we find enumerated in the *Āśvalāyana Gṛhya Sūtra* (III, 4, 4). The present compilation began from about the time of the Maurya emperors. There are in it mention of the Buddhist monks and the Buddhists in several places.[1] Again one astronomical statement runs thus:—

"First comes the day and then night, the months begin from the light half, *nakṣatras* begin with *Śravaṇā* and the seasons with winter."[2]

[1] Book I, Ch. 70: लोकायतिकमुख्यैश्च समन्तादनुनादितम् ॥ 2883 of Ādi Parva; Book VII, Ch. 45, St. 30, which runs thus: अथोदीच्याश्चाङ्गकामागधाश्च शिष्टान् धर्म्मानुपजीवन्ति बुद्धाः । Also Book XII, Ch. 218, Stanza 31, etc., contains the Buddhist doctrines of rebirth. Asiatic Society Edition of the *Mahābhārata*.

[2] अहः पूर्व्वं ततो रात्रिर्मासाः शुक्लादयः स्मृताः ।
श्रवणादीनि ऋक्षाणि ऋतवः शिशिरादयः ॥२॥

Aśvamedha, Ch. 44. St. 2

In 1931 A.D., the celestial longitude of *Śravaṇā* (*Altair*) was 300° 48′ 9″. According to the modern *Sūrya Siddhāntā*, the polar longitude of this star is 280°,[1] while Brahmagupta in his *Brāhmasphuṭa Siddhānta* quotes its earlier polar longitude as 278°.[2] Hence according to the former work, the star *Śravaṇā* itself marks the first point of the *nakṣatra* and according to the latter, the *nakṣatra* begins at 2° ahead of the star. The *Mahābhārata* stanza quoted above shows that the winter solstitial colure passed through the star *Altair* (*Śravaṇā*) itself or through a point 2° ahead of it, as the season winter is always taken in Hindu astronomy to begin with the winter solstice. The passage indicates that winter began when the sun entered the *nakṣatra Śravaṇā*. It shows that the star *Altair* had at that time a celestial longitude of 270° or 268°, the latter according to the *Brāhmasphuṭa Siddhānta*. The present longitude of *Altair* may be taken as 301° nearly. The total shifting of that solstitial point has now, therefore, been 31°, which indicates a lapse of time = 2232 years. This means the epoch to be the year 297 B.C. If we accept Brahmagupta's statement for the position of this star, the date is pushed up to 441 B.C. Hence there is hardly any doubt that the *Mahābhārata* began to be compiled in its modern form from 400 to 300 B.C.[3] Before this as we have said already, there were known two books the *Bhārata* and the *Mahābhārata* as mentioned in the *Āśvalāyana Gṛhya Sūtra*.[4] The great epic, as we have it now, has swallowed up both the earlier works, and the oldest strata in it can be found with great difficulty. The present book is in itself in the most discursive form. Whenever a topic is raised, it is dilated in a way which is out of proportion to the real story of the Pāṇḍava victory. In this way some of the stanzas of the old saga

[1] देश्वान्ते श्रवणास्थिति: ।

Sūrya Siddhānta, viii, 4.

[2] मकरेऽष्टनखै: ।

Brāhmasphuṭa Siddhānta, Ch. X, 3.

[3] *Cf.* S. B. Dīkṣita's भारतीय ज्योति:शास्त्र, p. 111, 2nd edition. He estimates the date at 450 B.C.

[4] "सुमन्तु-जैमिनि-वैशम्पायन-पैलसूत्रभाष्य-भारत-महाभारत-धर्माचार्या जानन्ति ।"

Āśvalāyana Gṛhya Sūtra, Ch. 3, K. 4, Sūtra 4.

have got displaced from their proper settings, as many details came to be woven often uncouthly, into the story.

The Time References from the Mahābhārata

We shall now try to set forth some of the time references as found in the present *Mahābhārata* which we understand to be the oldest, and which lead to the determination of the year of the Bhārata battle.

In these references quoted below, the days are indicated by the position of the moon near a star. No mention of *tithi* is made. We shall have the distinct references to the *Aṣṭakās*, *Āmāvāsyās* (not *amāvasyā*) or the period of moon's invisibility, and *Paurṇamāsīs*.

Nakṣatras in these references mean most probably single-stars or star groups. In later times of the *Vedāṅgas* there are indeed recognised 27 *nakṣatras* of equal space into which the ecliptic was divided, but we do not know the exact point from which this division was begun. It is, therefore, safer to take the *nakṣatras* to mean stars or star groups in this connection.

The *Mahābhārata* astronomical references which we are going to use for determining the year of the Bhārata battle, are *casual* or *incidental statements*, and as such do not directly state the time or the position of the equinoxes or the solstices of the year in which the event happened. They state firstly the moon's phases near to several stars at some of the incidents of the battle and secondly indicate the day on which the sun reached the winter solstice that year. We state them as follows:—

(i) In the *Udyoga Parva* or Book V, Ch. 142, the stanza 18 runs as follows:—

'From the seventh day from to day, there will be the period of the moon's invisibility; so begin the battle in that, as its presiding deity has been declared to be Indra.'[1]

This is taken from the speech of Kṛṣṇa to Karṇa at the end of his unsuccessful peace-mission to the Kaurava-court. It means

[1] सप्तमाच्चापि दिवसादामावास्या भविष्यति ।
संग्रामं युज्यतां तस्यां तामाहुः शक्रदेवताम् ॥
Bk. V, Ch. 142, St. 18.

that before the battle broke out there was a new-moon near the star *Antares* or *Jyeṣṭhā* of which the presiding deity is Indra. As invisibility of the moon was taken to last two days, and only one presiding deity is mentioned, this presiding deity Indra, shows the star *Jyeṣṭhā* near which happened the new-moon. This new-moon marked the beginning of the synodic month of *Agrahāyaṇa* of the year of the battle.

Again from the fifth case-ending in '*saptamāt*,' 'from the seventh day from to-day' shows that when the speech was made, the *Aṣṭakā* or the last quarter of the current month of *Kārttika* was just over. At the mean rate the moon takes about 7·5 days to pass from *Regulus* to *Antares*. Hence in the latter half of the previous night the straight edge of the dichotomised moon was probably observed as almost passing through the star *Regulus*. This formed the basis of this prediction of the coming new-moon. The moon's invisibility was thus to begin from the 7th day and last till the day following. We further learn that while Kṛṣṇa was negotiating for peace at the Kaurava Court, there was a day when the moon neared the *nakṣatra Puṣyā* (δ, η, γ *Cancri*) group, from Duryodhana's command which was thus expressed :—

"He repeatedly said 'march ye princes, to Kurukṣetra ; today the moon is at *Puṣyā*.'"[1]

The day on which Kṛṣṇa addressed Karṇa was the fourth day from that day.

Hence in the year of the battle, the last quarter of *Kārttika* took place near the star *Regulus* and the next new-moon near the star *Antares* which marked the beginning of the lunar month of *Agrahāyaṇa*. But the battle did not actually begin with this new-moon. For on the eve of the first day of the battle Vyāsa thus speaks to Dhṛtarāṣṭra :—

(*ii*) "Tonight I find the full moon at the *Kṛttikās* (*Pleiades*) lustreless, the moon became of a fire-like colour in a lotus-hued heaven."[2]

[1] प्रयाध्वं वै कुरुक्षेत्रम् पुष्योऽद्येति पुन: पुन: ।

M. Bh., *Udyoga*, 150, 3.

[2] अलक्ष्ये प्रभया हीनां पौर्णमासीं च कार्त्तिकीम् ।
चन्द्रोऽभूदग्निवर्णश्च पद्मवर्णे नभ:स्थले ॥

M. Bh., *Bhīṣma Parva* or BK. VI, Ch. 2, 23.

If there be a new-moon at the star *Antares*, the next full-moon cannot be at the star group *Pleiades*. At the mean rate the moon takes exactly 12 days 23 hours or about 13 days to pass from the star *Antares* to *Pleiades*. The moon was about 13 days old and not full. Vyāsa by looking at such a moon thought the night to be *Paurṇamāsī* no doubt, but it was of the *Anumati* type and not of the type *Rākā*, which was the next night. There are other references to show that the moon could not be full on the eve of the first day of the battle.

On the fourteenth day of the battle, Jayadratha, Duryodhana's brother-in-law, was killed at sunset; the fight was continued into the night, and at midnight the *Rākṣasa* hero Ghaṭotkaca was killed. The contending armies were thoroughly tired and slept under truce on the battle-field itself.[2] The fighting was resumed when the moon rose sometime before sunrise. How and when the fight was resumed are described in the following way:—

(*iii*) "Just as the sea is raised up and troubled by the rise of the moon, so up-raised was the sea of armies by the rise of the moon, then began again the battle, O King, of men wishing blessed life in the next world for the destruction of humanity."[3]

As to the time when the fight was resumed we have the statement:

[1] *Aitareya Brāhmaṇa*, Ch. 32, 10.
या पूर्वा पौर्णमासी सानुमतिर्योत्तरा सा राका या पूर्वामावास्या सा सिनीवाली योत्तरा सा कुहूः।

[2] अर्द्धरात्रिः समाजज्ञे निद्रान्धानां विशेषतः।
सर्व्वे ह्यासन्निरुत्साहाः क्षत्रिया दीनचेतसः ॥१६॥
ते यूयं यदि मन्यध्वमुपारमत सैनिकाः।
निमीलयत चात्रैव रणभूमौ मुहूर्त्तकम् ॥२७॥
ततो विनिद्रा विश्रान्ता श्चन्द्रमस्युदिते पुनः।
संसाधयिष्यथान्योन्यं संग्रामं कुरुपाण्डवाः ॥२८॥

M. Bh., *Droṇa*, Ch. 185.

[3] यथा चन्द्रोदयोद्भूतः क्षुभितः सागरोऽभवत्।
तथा चन्द्रोदयोद्भूतः स बभूव बलार्णवः ॥५५॥
ततः प्रववृते युद्धं पुनरेव विशाम्पते
लोके लोकविनाशाय परलोकमभीप्सताम् ॥५६॥

M. Bh., *Droṇa*, Ch. 185.

(*iv*) " The battle was resumed when only one-fourth of the night was left."[1]

Here 'one-fourth' must mean some small part as we cannot think that they could exactly estimate 'one-fourth of the night.' Thus the moon rose that night when only a small part of it was left, and the description of the moon as it rose was

(*v*) " Then the moon which was like the head of the bull of Mahādeva, like the bow of Cupid fully drawn out, and as pleasant as the smile of a newly married wife, slowly began to spread her golden rays."[2]

It was a crescent moon with sharp horns like those of a bull, that rose sometime before sunrise, and was 27½ days old. From this it is clear that the Bhārata battle was not begun on the new-moon day spoken of in our reference (*i*); and on the eve of the first day of the battle she was not quite full but about 13 days old. As has been said already the night before the first day of the battle was a *Paurṇamāsī* of the *Anumati* type—it was not *Rākā*.

On the 18th day of the battle, Kṛṣṇa's half-brother Valadeva was present at the mace-duel between Duryodhana and Bhīma. He just returned from a tour of pilgrimage to the holy places. His words were:—

(*vi*) " Since I started out, to-day is 40 days and 2 more; I went away with the moon at *Puṣyā* and have returned with the moon at *Śravaṇā* (*Altair*)"[3]

Hence on the day of the mace-duel, the moon was near to the star *Altair*, and at the mean rate the moon takes about 18 days and 8⅓ hours to pass from *Alcyone* to *Altair*. Owing to the moon's unequal motion it is quite possible for her to accomplish this journey in 18 days. Hence this passage confirms the statement made above that on the eve of the first day of the battle

[1] त्रिभागमात्रशेषायां रात्र्यां युद्धमवर्त्तत ॥१॥

M. Bh., Droṇa, Ch. 187.

[2] हरवृषोत्तमगात्रसमद्युतिः स्मरशरासनपूर्णसमप्रभः ।
नववधूस्मितचारुमनोहरः प्रविसृतः कुमुदाकरबान्धवः ॥४८॥

M. Bh., Droṇa, Ch. 185.

[3] चत्वारिंशदहान्यद्य द्वे च मे निःसृतस्य वै ।
पुष्येण संप्रयातोऽस्मि श्रवणे पुनरागतः ॥

M. Bh., Śalya, Ch. 34, 6.

the moon was near to the star group *Kṛttikās* or *Alcyone* and that she was about 13 days old. For—

From the day of the moon at *Puṣyā* till the day of Kṛṣṇa's speech to Karṇa	3 days
From that day till the new-moon at *Antares* (*Jyeṣṭhā*)	8 ,,
From the new-moon at *Antares* till the moon at the *Kṛttikās*	13 ,,
And the fight had already lasted	17 ,,
Total ...	41 days

The next day was the last day of the battle and was the 42nd day from the day when the army of Duryodhana marched to Kurukṣetra and Valadeva started out on his tour.

On the 10th day of the battle at sunset, Bhīṣma, the first general of the Kaurava army, fell on his 'bed of arrows,' became incapacitated for further participating in the fight and expired after 58 days, as soon as it was observed that the sun had turned north. Yudhiṣṭhira came to the battle-field to see Bhīṣma expire and to perform the last rites. The *Mahābhārata* passage runs thus:—

(*vii*) "Yudhiṣṭhira having lived at the nice city of Hastināpura for fifty nights (after the battle was over), remembered that the day of expiration of the chief of the Kauravas (*i.e.*, Bhīṣma) had come. He went out of Hastināpura with a party of priests, after having seen (or rather inferred) that the sun had stopped from the southerly course, and that the northerly course had begun."[1]

It is clear that special observation of the winter solstice day was made in the year of the battle, as Bhīṣma was to expire as soon as it was observed that the sun had turned north. Yudhiṣṭhira started most likely in the morning from his capital to meet Bhīṣma on the battle-field. After the lapse of 50 nights

[1] उषित्वा शर्व्वरीः श्रीमान् पञ्चाशन्नगरोत्तमे ।
समयं कौरवाग्र्यस्य सस्मार पुरुषर्षभः ॥५॥
स निर्ययौ गजपुराद् याजकैः परिवारितः
दृष्ट्वा निवृत्तमादित्यं प्रवृत्तं चोत्तरायणम् ॥६॥

M, *Bh*., *Anuśāsana*, or BK. XIII, Ch. 167

from the evening on which the battle ended he was sure that the sun had turned north. Hence the day of Yudhiṣṭhira's starting out from his capital was the day following the winter solstice day. When Yudhiṣṭhira met Bhīṣma at Kurukṣetra, he (Bhīṣma) thus spoke to him :—

(*viii*) "It is a piece of good luck, O Yudhiṣṭhira, the son of Kuntī, that you have come with your ministers. The thousand rayed glorious Sun has certainly turned back. Here lying on my bed of pointed arrows, I have passed 58 nights ; this time has been to me as endless as a hundred years. O Yudhiṣṭhira, the lunar month of Māgha is now fully on and its three-fourths are over. This ought to be the light half of the month."[1]

Here the last sentence was a pious wish not materialised. In our reference (*vii*) '50 nights' and in (*viii*) '58 nights' are corroborative of each other. A lapse of 50 nights from the end of the battle and that of 58 nights from the evening on which Bhīṣma fell on his "bed of arrows," both indicate the same day. Three-fourths of *Māgha* became over at the last quarter or the *Ekāṣṭakā* day. The time indication is peculiarly identical with that of the *Brāhmaṇas*. The lunar months here used are undoubtedly from the light half of the month, for reasons set forth below :

(*a*) Time from the new-moon at *Antares* to the moon's reaching the *Kṛttikās* or *Pleiades* ...	13 days
Bhīṣma's generalship	10 ,,
Bhīṣma on death-bed	58 ,,
Total ...	81 ,,

(*b*) From the new-moon at *Antares* or the beginning of the lunar *Agrahāyaṇa* till its end ...	29·5 days
The lunar month of *Pauṣa*	29·5 ,,
¾ of the lunar month of *Māgha*	22·0 ,,
Total ...	81 ,,

[1] दिष्ट्या प्राप्तोऽसि कौन्तेय सहामात्यो युधिष्ठिर ।
परिवृत्तो हि भगवान् सहस्रांशुर्दिवाकरः ॥२६॥
अष्टपञ्चाशतं रात्र्यः शयानस्याद्य मे गताः ।
शरेषु निशिताग्रेषु यथा वर्षशतं तथा ॥२७॥
माघोऽयं समनुप्राप्तो मासः सौम्यो युधिष्ठिर ।
त्रिभागशेषः पक्षोऽयं शुक्लो भवितुमर्हति ॥२८॥

M. Bh., *Anuśāsana* or Bk XIII, Ch. 167

Hence the two reckonings are corroborative of each other. If, on the other hand, we assume that the lunar months counted here were from the dark-half of the month and ending with the light half, the synodic month of *Agrahāyaṇa* would be half over with the new-moon at *Antares*. From that time till ¾th of *Māgha* were over, we could get only :—

(c) Half of *Agrahāyaṇa*	...	...	.. 14·75 days
Month of *Pauṣa*	...	...	... 29·50 ,,
¾ of *Māgha* ...	...	...	... 22·00 ,,
		Total	... 66·25 ,,

The number of days here counted falls short of the 68 days which comprised Bhīṣma's generalship of 10 days + 58 days in which he was on death bed. It is thus evident that the lunar months which end with the full-moon and half a month earlier than the new-moon ending lunar months, are not used in these *Mahābhārata* references.[1] It is also clear that the *Mahābhārata* says that Bhīṣma expired at sunset on the day of the last quarter of *Māgha*. So far as astronomical calculation is concerned, we take that the sun reached the winter solstice one day before the expiry of Bhīṣma, or that full 49 nights after the battle ended, the sun reached the winter solstice according to our reference (*vii*). We are inclined to think that in this reference a clear statement occurs as to the observation of the winter solstice day, no matter even if the reference (*viii*) be a fiction.

To sum up:—In the year of the Bhārata battle, there was the last quarter of the month of *Kārttika* with the moon near about the star *Regulus* as we have inferred. Secondly, in that year the beginning of the next month of *Agrahāyaṇa*

[1] The original word in place of *Śukla* was perhaps *Kṛṣṇa* and a subsequent redactor changed the word to *Śukla*, to bring out the approved time for the death of Bhīṣma. Nīlakaṇṭha, the commentator of the *Mahābhārata* quotes a verse from the *Bhārata Sāvitrī*, which also says that 'Bhīṣma was killed by Arjuna on the 8th day of the dark half of the month of *Māgha*' : see *Bhīṣma Parva*, ch. 17, stanza 2. In an edition of the *Bhārata Sāvitrī* the verse runs as 'Bhīṣma was killed in the month of Agrahāyaṇa on the 8th day of the dark half.' This of course refers to the day on which Bhīṣma fell on his 'bed of arrows'; 58 days after that, *i.e.*, exactly one day less than full two synodic months becomes the 7th day of *dark* half of *Māgha*. Hence also Bhīṣma expired in the dark half of *Māgha* and not in the light half.

took place with the new-moon near the star *Antares* or *Jyeṣṭhā*, which is directly stated. Thirdly, the battle lasted till the moon reached the star *Altair* or *Śravaṇā*. Fourthly, when 49 nights after the battle expired, the sun reached the winter solstice. We are to understand by the term '*Nakṣatra*' simply a star or a star-group. We should also recollect that Bhīṣma expired on the day of the last quarter of *Māgha* and, as we have understood, the sun's reaching the winter solstice took place one day earlier.

From these references it is possible to determine the date of the Bhārata battle. We shall use **two methods**, but the results obtained from both the methods will be approximate. In the first method we shall, for the sake of convenience, assume that *the nearness of the moon to the several stars as equivalent to exact equality in celestial longitude of the moon with those stars.* With this meaning of 'nearness' we may derive the following sets of data for finding the year of the Bhārata battle.

Data for the calculation of the Date of the Bhārata battle by the **First Method**

(*a*) There was a new-moon at the star *Antares*, before the battle broke out and the sun turned north in 80 days, *i.e.*, one day before Bhīṣma's expiry.

(*b*) On the eve of the first day of the battle, the moon 13 days old was in conjunction with the *Kṛttikās or Alcyone*, and the sun turned north in 10 + 57 = 67 days.

(*c*) On the 18th day of the battle, moon 31 days old was in conjunction with *Śravaṇā* or *Altair*, and the sun turned north in 49 days.

Calculation of Date by the First Method

Before we can proceed with our calculation we note down below the mean celestial longitudes of the stars concerned for the year 1931.

Star	Mean celestial longitude
Jyeṣṭhā or *Antares*	248° 47′ 57″
Kṛttikā or *Alcyone*	59° 1′ 41″
Śravaṇā or *Altair*	300° 48′ [illegible]″

(A) From the data (*a*) we assume, as already stated, that the sun, the moon and the star *Antares* had the same celestial longitude at that new-moon.

Hence the present (1931) longitude of the sun at the new-moon at *Antares*	248° 47′ 57″
Sun's motion in 80 days ...	78° 51′ 6″
Hence the mean celestial long. in 1931 of the sun for reaching the winter solstice of the year of the Bhāraṭa battle	327° 39′ 3″ (1)

(B) From the data (*b*), the moon at the assumed conjunction with *Kṛttikā* or *Alcyone* was 13 days old.

Hence the (1931) celestial longitude of the moon at that time was	59° 1′ 44″
The moon was 13 days old and the mean synodic month has a length of 29·530588 days	
∴ the moon was ahead of the sun by $\frac{360° \times 13}{29·530588}$ or ...	158° 28′ 47″
∴ the sun's present day (1931) mean celestial longitude for that time	260° 32′ 57″
Sun's motion in 67 days ...	66° 2′ 18″
Hence the present (1931) mean celestial longitude of the sun for reaching the winter solstice of the year of the Bhārata battle	326° 35′ 15″ (2)

(C) From data (*c*) the moon at our assumed conjunction with *Śravaṇā* or *Altair* was 31 days old.

Hence the present (1931) celestial longitude of the moon for that time	300° 48′ 9″
The moon was ahead of the sun by $\frac{360° \times 31}{29·530588}$ or ...	377° 54′ 48″
∴ the present (1931) celestial long. of the sun for that time ...	282° 53′ 21″
Sun's motion in 49 days ...	48° 17′ 48″
Hence the (1931) mean celestial longitude of the sun for reaching the winter solstice of the year of the Bhārata battle ...	331° 11′ 9″ (3)

We thus arrive at three divergent values of the present (1931) mean celestial longitude of the sun for reaching the winter solstice of the year of the Bhārata battle, *viz.*:

From data (*a*)	327°	39′	3″,	result	(1)
,, ,, (*b*)	326°	35′	15″,	,,	(2)
,, ,, (*c*)	331°	11′	9″,	,,	(3)
The mean of these values =	328°	28′	29″		

From the above calculations, the present (1931) mean tropical longitude of the sun at the winter solstice of the year of the Bhārata battle is the mean of the results (1), (2) and (3), *viz.*, 328° 28′ 29″.

Hence as a first step the total shifting of the winter solstice up to 1931 A.D. is roughly 328° 28′ 29″ − 270° = 58° 28′ 29″, which represents a lapse of 4228 years[1].

Now 42 centuries before 1900 A.D., the longitude of the sun's apogee was about 29°. Hence allowing for the change in the eccentricity of the sun's apparent orbit, the sun's equation of centre for the *mean* longitude of 270° in the year of the Bhārata battle works out to have been + 1° 51′ nearly.

Hence what was 270° of the longitude of the sun in the battle year, was 328° 28′ *plus* 1° 51′ (= 330° 19′) in the year 1931 A.D., which shows a solsticial shifting of 60° 19′ and represents a lapse of 4362 years.

The year of the Bhārata battle thus becomes near to **2432 B.C.** This is the best result that can be obtained from our first method.

Calculation of Date by the **Second Method**

On looking up some of the recent calendars, we find that a new-moon very nearly at the star *Antares* took place on:—

(1) December 1, 1929, at 4 hrs. 48·4 min. G. M. T. or at 9 hrs. 56·4 min Kurukṣetra mean time.

[1] Annual rate of precession = 50″·2564 +0″ 0222 T, where T = no. of centuries from 1900 A D. As a first appoximation, with the annual rate of 50″ 25, the solstices take 4183 years to recede through 58° 27′ 28″. Now from the above equation the annual rate for 1931 A.D. is 50″·2633, and 4188 years earlier (*i.e.*, 4157 years before 1900 A.D.) it was 49″·3335. Working with the mean of the two values (*viz* 49″ ·7984) the lapse of years comes out to be 4228.

The sun's longitude at G. M. midnight or Kurukṣetra mean time 5 hrs. 8 min. A. M. was 248° 19′ 10″

The moon's longitude at that time	246° 4′ 24″
The longitude of *Antares*	248° 46′ nearly

Hence December 1, 1929 was a new-moon day, the conjunction taking place very near to *Antares*. It was the day of the new-moon of which the presiding deity was Indra and it was the beginning of the synodic month of *Agrahāyaṇa*. Thirteen days later was—

(2) December 14, 1929 ; at 5-8 P.M. of Kurukṣetra mean time which corresponded with the eve of the first day of the Bhārata battle :

The sun's longitude	262° 1′ 57″
The moon's longitude	54° 40′ 7″
The longitude of *Kṛttikā* or *Alcyone*	59° nearly

The moon came to conjunction with *Kṛttikā* in about 8⅓ hrs. more. In the evening at Kurukṣetra, the moon was about 3° behind the *Kṛttikās* visibly, the moon being affected by parallax due to its position near the eastern horizon at nightfall. Eighteen days later was—

(3) January 1, 1930 ; at 5-8 P.M. of Kurukṣetra mean time :

The sun's longitude	280° 22′ 2″
The moon's longitude	296° 47′ 35″
The longitude of *Altair* or *Śravaṇā*	300° 45′ nearly

The moon came to conjunction with *Altair* in 8 hours more. This evening corresponded with the evening on which the Bhārata battle ended. Fifty days later came—

(4) 20th February, 1930 ; the day corresponding to that of Bhīṣma's expiry. At 5-8 P.M. of Kurukṣetra mean time :

The sun's longitude	331° 8′ 1″
The moon's longitude	242° 40′ 55″

The moon had come to her last quarter at about 1¼ hrs. before.

Assuming that the sun turned north exactly one day before Bhīṣma's expiry, as before, the true anniversary of the winter solstice day of the year of the Bhārata battle fell on the 19th February, 1930.

On the evening of the 19th February, 1930 A.D., at 5-8 P.M. of Kurukṣetrā time which was the G. M. noon of that day, the sun's *mean* tropical longitude was 328° 42′ nearly which is in excess of the value obtained by the first method by 15′ only.

By a similar process shown before in our first method, we deduce that the sun's equation of centre for the sun's *mean* longitude of 270° in the year of the battle was +1° 51′ nearly.

Hence what was 270° in the year of the battle was 328° 42′ + 1° 51′ *i.e.* 330° 33′ in 1930 A.D.

The total shifting of the solstices up to 1930 A.D. thus becomes 60° 33′ representing a lapse of 4379 years.

The battle year should be thus very near to 2450 B.C.

By the first method we have arrived at the date 2432 B.C., while our second method gives the year 2450 B.C. We have now to examine if there is any tradition which supports these findings.

Three Traditions as to the Date of the Bhārata Battle

There are at present known three orthodox traditions as to the date of the Bhārata battle.

(1) The first of the traditions is due to Āryabhaṭa I (499 A.D.), who in his *Daśagītikā*, 3, says 'of the present *Kalpa*, or Æon, six *Manus*, 27 *Mahāyugas* and three quarter *Yugas* elapsed before the Thursday of the Bhāratas '[1]. This is a simple statement that the Pāṇḍavas lived at the beginning of the astronomical Kali age or at about 3102 B.C.

(2) The second tradition recorded by Varāhamihira (550 A.D.) is ascribed by him to an earlier astronomer Vṛddha Garga (much earlier than Āryabhaṭa I). Varāha says ' The seven *ṛṣis* were in the *Maghās*, when the King Yudhiṣṭhira was reigning

[1] काह्नो मनवो ढ मनुयुग श्ख गतास्ते च मनुयुगछ्ना च ।
कल्पादेर्युगपादा ग च गुरुदिवसाच्च भारतात् पूर्व्वम् ॥

Daśagītikā, 3.

over the earth ; his era is the era of the Śaka Kings to which 2526 have been added '[1]. The first part of this statement has remained a riddle to all researchers up to the present time. The second part gives a most categorical statement that Yudhiṣṭhira became King in —2526 of Śaka era, which corresponds to 2449 B.C.

(3) The third tradition is due to an astronomical writer of the *Purāṇas*, who says, ' From the birth of Parīkṣit to the accession of Mahāpadma Nanda, the time is one thousand and fifty years (or one thousand fifteen years or one thousand five hundred years).'[2]

Now taking the accession of Chandragupta to have taken place in 321 B C., and the rule of the Nandas to have lasted 50 years in all, the birth of Parīkṣita, according to the statement of this *Purāṇic* writer, becomes about 1421 B.C. or 1871 B.C.

Of these three traditions our finding of the date of the Bhārata battle, whether 2432 or 2450 B.C. approaches closest to the year, — 2526 of the Śaka era or 2449 B.C. It is, therefore, necessary to examine the year, – 2526 of the Śaka era.

Astronomical Examination of the year,— 2526 of the Śaka era or 2449 B.C.

We have found before that in 1851 of Śaka era elapsed or 1929 – 30 A.D., the various ' conjunctions ' of the moon with the sun and the several stars happened in closest coincidence with the *Mahābhārata* references.

From,—2526 to 1851 elapsed of the Śaka era, the number of years was 4377. We shall assume that these were sidereal years.

[1] आसन् मघासु मुनयः शासति पृथ्वीं युधिष्ठिरे नृपतौ ।
षड्द्विकपञ्चद्वियुतशककालस्तस्य राज्ञश्च ॥

Bṛhatsaṁhitā, xiii, 3.

[2] यावत् परीक्षितो जन्म यावत् नन्दाभिषेचनम् ।
एवं वर्षसहस्रं तु ज्ञेयं पञ्चाशदुत्तरम् ॥

(पञ्चदशोत्तरम्—पञ्चशतोत्तरम् पाठान्तरे)

Pargiter's *Dynasties of the Kali Age*, p. 58.

Now,

$$\frac{\text{Sidereal year}}{\text{Sidereal month}} = \frac{365{\cdot}25636}{27{\cdot}32166}$$

$$= 13 + \frac{1}{2+}\ \frac{1}{1+}\ \frac{1}{2+}\ \frac{1}{2+}\ \frac{1}{8+}\ \frac{1}{12+}\ \frac{1}{7+}\ \cdots\ \cdots$$

The successive convergents are

$$13,\ \frac{27}{2},\ \frac{40}{3},\ \frac{107}{8},\ \frac{254}{19},\ \frac{2139}{160},\ \frac{25922}{1939},\ \text{etc.}$$

The last three of the above convergents give the luni-solar cycles of 19, 160 and 1939 years in which the moon's phases with respect to the sun and the stars repeat themselves.

Here we have $4377 = 1939 \times 2 + 160 \times 4 + 19$.

In fact we have—

Sidereal year × 4377 = 1598727·092 days

Sidereal month × 58515 = 1598726·993 ,,

and Synodic month × 54138 = 1598726·978 ,,

Thus from a consideration of the mean motions of the sun and the moon, it is inferred as a certainty that the various 'conjunctions' of the moon with the sun and the stars recorded in the *Mahābhārata* did actually happen in —2526 of Śaka era or 2449 B.C. Here the *Mahābhārata* references enable us to construct the battle calendar; we further, want to see how the various phases of the moon near to the fixed stars happened in the battle-year on the days stated, and how the winter solstice day stood in the year in relation to the day of Bhīṣma's expiry.

Construction of the Battle Calendar

It has been said before that a new moon near the star *Antares* happened in our times on December 1, 1929 A.D., which we have taken to have been more or less exactly similar to that which happened in the year of the battle.

Now Julian Days on Dec. 1, 1929 =2425947,
less no. of days in 54138 synodic months=1598727, as shown above.
∴ Julian days for the required date =827220, whence
the date arrived at is October 21, 2449 B.C.

Now Julian days on Jan. 1, 1900 A.D. =2415021,
and Julian days on Oct. 21, 2449 B.C. =827220.

Difference =1587801 days
=43·47 Julian centuries
+59·25 days.

(1) Hence on Oct. 21, 2449 B.C. at G.M.N.

Mean Sun =189°25′45″·15,
,, Moon =191°18′ 4″.25,
Lunar Perigee=188°26′44″·75,
A Node =103° 9′53″ 75,
Sun's Apogee =27° 4′ 2″·71,
Sun's eccentricity =0·01833.

∴ apparent Sun=188°40′,
,, Moon=191°46′,
Mean Longitude of *Antares*=188°13′ nearly

The new moon near *Antares*, happened about 6 hrs. before, *i.e.*, at 11−8 A.M. Kurukṣetra mean-time and conjunction took place very near to the star *Antares*, which is the junction star of the *nakṣatra Jyeṣṭhā*. This new moon is mentioned in the *Mahābhārata* reference (*i*) cited before.

(2) We have next on Nov. 3, 2449 B.C. at G.M.N., or Kurukṣetra mean time 5-8 P.M.

Mean Sun =202°14′33″,
,, Moon = 2°25′40″,
Lunar Perigee=189°53′39″,
A. Node =120°28′36″.

∴ Apparent Sun=202°4′
,, Moon= 3°34′
Mean longitude of *Kṛttikā* or *Alcyone*=358°30′ nearly.

The conjunction of the moon with the *Kṛttikās* had happened about 10 hrs. before, *i.e.*, about 7-8 A.M. Kurukṣetra mean-time This phase of the moon is mentioned in the *Mahābhārata* reference (*ii*) quoted before. At sunset the moon was about 6° below the *Kṛttikās*.

(3) THE BATTLE BEGAN from Nov. 4, 2449 B.C. or the day following. The mean longitude of *Rohiṇī* junction star or *Aldebaran* was 8°17′; the conjunction of the moon with *Rohiṇī* had taken place on the preceding night at about 2·30 A.M. Kurukṣetra mean time.

(4) On Nov. 18 at G.M.T. 0 hr. or 5 8 A.M. Kurukṣetra mean time.

Mean Sun = 216°32′ 4″,	Apparent Sun = 216°53′
,, Moon = 193°39′ 8″,	,, Moon = 192°25′
L. Perigee = 191°30′34″,	Moon's celestial
A. Node = 101°42′32″.	latitude = 5°8′42″ N.

Hence in the morning of Nov. 18, 2449 B.C., the sunrise happened at 6-23 A.M. of Kurukṣetra meantime and the moon rose at 4 29 A.M. of K.M.T.

Thus the moon which was crescent rose about 1 hr. 54 min. before the sunrise. This moonrise is spoken of in the *Mahābhārata* references (*iii*), (*iv*) and (*v*) quoted before.

(5) On Nov. 21, at G. M. N., or K. M. T., 5-8 P.M.

Mean Sun = 219°59′ 3″,	Appt. Sun = 220°28′
,, Moon = 239°46′11″,	,, Moon = 244°47′.
Lunar Perigee = 191°53′57″,	Mean long. of *Sravaṇā* (*Altair*)
A. Node = 101°31′25″	= 240°17′ nearly.

ON THIS DAY THE BATTLE ENDED, and the moon had been conjoined with the 'junction star' *Sravaṇā* about 8½ hrs. before. This was the day of the first visibility of the crescent after the preceding new-moon. For on the preceding day, the 20th Nov., 2449 B.C. at G. M. Noon,

Appt. Sun = 219°27′,
,, Moon = 230° 5′,
A. Node = 101°35′.
Moon's celestial latitude = 4°1′28″N nearly.
Moon − Sun = 10°38′ only.

Hence the moon was not visible at nightfall on this day.

The month of lunar *Pauṣa* was most probably reckoned from this 20th Nov., 2449 B.C. by the calendar authorities of the Pāṇḍava time.

(6) Lastly on Jan. 10, 2448 B.C. at G.M.N. or K.M.T., 5-8 P.M.,

Mean Sun=269°16′ 0″,	Appt. Sun=271° 9′,
,, Moon=178°35′22″	,, Moon=175°52′.
Lunar Perigee=197°28′10″	
A. Node= 98°52′33″.	

Thus the sun had reached the winter solstice about 28 hours before, *i.e.*, on the preceding day as already explained. The moon came to her last quarter in about 10½ hrs. later. Bhīṣma expired on this day at about the time for which the longitudes have been calculated. The date of the Bhārata battle is thus astronomically established as the year 2449 B.C. which is supported by the *Vṛddha-Garga* Tradition recorded by Varāhamihira.

Are the Mahābhārata References Later Interpolations? [1]

The striking consistency of the *Mahābhārata* references, may lead some critics of our finding to propound the theory that these were all later additions by the epic compiler of about 400 B.C., made with the help of an astronomical assistant of his time. We are, however, of opinion that such a hypothesis as to their origin is not justifiable.

Firstly, these astronomical references are not all collected at any single place: they are scattered over the battle books from the *Udyoga* to *Anuśāsana*.

Secondly, the knowledge of astronomy, developed in India from the earliest times up to 400 B.C., could not enable any

[1] Prof. Dr M. N. Saha in his paper in "Science and Culture" for March, 1939 pp. 482-488, raised this question. The author of the present work replied to this in the "Science and Culture," July, 1938 in pp. 26-29.

astronomical assistant to determine the set of those astronomical references which we have used in this chapter. So far as our studies go, neither the astronomy of the *Brāhmaṇas*, nor of the *Vedāṅgas*, nor of the *Paitāmaha Siddhānta* as summarised in the *Pañcasiddhāntikā* of Varāhamihira, was equal to the task. The arguments in favour of our position are set forth below as briefly as possible.

From the *Mahābhārata* references cited above, we have evolved two astronomical data for the determination of the year of the Bhārata battle: (*i*) that the year of the battle was similar to the year 1929-30 A.D. of our times in so far as the moon's phases near to the fixed stars are concerned, and (*ii*) that the observers of the sun appointed by the Pāṇḍavas were satisfied that the sun's northerly course had begun exactly after a lapse of 50 nights from the evening on which the battle ended

Before the battle broke out there was a new-moon near the star *Antares*, from which the lunar month of *Agrahāyaṇa* began in the year. Thirteen days later in the evening, the moon nearly full, was observed near the star group *Kṛttikās* or *Pleiades*. The battle began from the next morning. On the night following the fourteenth day of the battle, a crescent moon rose sometime before the day-break. On the 18th or the last day of the battle, the moon was conjoined with *Śravaṇā* or *Altair*.—Exactly fifty nights after the battle ended, Yudhiṣṭhira was satisfied that the sun had turned north or that the sun had reached the winter solstice one day earlier.

As regards the repetitions of the moon's phases near to the fixed stars they occur at intervals of 19 or 160 and 1939 sidereal years. Hence by the mere repetition of these phases of the moon near to the fixed stars, no date of any past event can be determined. Coupled with these repetitions of the lunar phases, we must exactly know where the winter solstice day stood in relation to these phases or the lunar months of the year in which the event happened. Here as shown before, the interval from January 1 to February 20 of 1930, is exactly 50 days.

We now proceed to show that the interval of 50 days between the end of the battle and the first day of the sun's northerly course of the year, could not be predicted by the astronomical

knowledge that developed in India from the earliest times up to 400 B.C. In Vedic times, for starting the five yearly luni-solar cycle or *lustrum*, a peculiar synodic month of *Māgha* was used from about 3000 B C. This lunar Māgha had these three important features (*i*) that it should have for its beginning the new-moon at *Dhaniṣṭhā* (*Delphinis*), (*ii*) its full-moon at the star *Maghā* (*Regulus*) and (*iii*) its last quarter at the star *Jyeṣṭhā* (*Antares*).[1] In spite of these well pronounced characters, it could not be a sidereally fixed lunar month. In our times such a month of *Māgha* happened truly, according to our estimate, in the years 1924, 1927, 1932 and 1935 A.D. The beginning of this standard *Māgha* oscillates between the 2nd and 6th of February, and its end between the 3rd and 7th of March. According to Varāhamihira such a *Māgha* came in the year 2 of *Śaka* elapsed or 80 A.D., and this year was similar to 1924 A.D. of our time. If we allow a slightly greater latitude, the year 1929 had also this type of *Māgha* from the 9th of February to the 11th of March. Hence both the years 1924 A.D. and 1929 A.D. were suitable for starting the Vedic five-yearly cycle, the former being more suitable than the latter.

Now 1924 A.D., had the same lunar phases as 2454 B.C., and 1929 A.D., the same as the year 2449 B.C. This latter year has become the year of the Bhārata battle according to our finding. Between the years 1924 A.D. and 1929 A.D., we had a Vedic luni-solar cycle of 5 years, and a similar *lustrum* existed between 2454 B.C. and 2449 B.C. Here the battle year was similar to 1929 A.D., as has been shown already, and the year exactly preceding the battle year by one *lustrum* was similar to 1924 A.D.

(1) First, let us suppose that the full-moon day of *Māgha* and the winter solstice day were the same day in the year similar to 1924 A.D., exactly one *lustrum* before the battle year which was similar to 1929 A.D.[2] Hence the five-yearly Vedic cycle

[1] This topic has been fully discussed in Chapter XIII on 'Solstice days in Vedic Literature.'

[2] The reference is here to the age when *Pleiades and Regulus* were, respectively near to the vernal equinox and the summer solstice, i.e., about 2150 B C.

started therefrom would end on the full-moon day of *Māgha* of the battle year. It would then be usual to start the Vedic *lustrum* anew from the day following the full-moon day of *Māgha* of the battle year, and this full-moon day would be taken for the winter solstice day according to the reckoning used. Now one Vedic year consisted of 12 lunations *plus* 12 nights; hence the estimated day of the next winter solstice would be the 27th day of lunar *Māgha* to come. The 28th day of this *Māgha* would be the first day of the sun's northerly course. This day would correspond with the 27th February of 1930 A.D. of our time. Hence the predicted first day of the sun's northerly course, and the last day of the battle which corresponded with January 1, 1930 A.D., would have between them *an interval of 57 days and not 50 days as found by observation.* Thus the predicted day of winter solstice could not generally agree with the accurately observed winter solstice day in the Pāṇḍava times. This is also illustrated from the following verse of the *Mahābhārata*, which contains Kṛṣṇa's prediction of the first day of the sun's northerly course on which Bhīṣma was to expire.

"O chief of Kurus, there still remain 56 days more of your life: then laying aside this body you will attain those blissful worlds which are the fitting rewards of your good deeds in this world."[1]

This verse of the original saga is found displaced from its proper setting in the present recensions of the *Mahābhārata*. Kṛṣṇa must have addressed these words to Bhīṣma at the conclusion of the fight or on the day following. We shall discuss this stanza more fully in the next chapter.

(2) Secondly, let us suppose that 5 years before the beginning of the battle year, it was found by observation that the day of the new-moon of *Māgha* begun, was the winter solstice day[2]; then at

[1] पञ्चाशतं षट् च कुरुप्रवीर शेषं दिनानां तव जीवितस्य ।
ततः शुभैः कर्म्मफलोदयैस्त्वं समेष्यसे भीष्म विमुच्य देहम् ॥

M.Bh., *Śānti*, 51, 44.

[2] Reference is here to the time about 1400 B.C., the date of the *Vedāṅgas*.

the end or termination of the five-yearly cycle at the starting of the battle year, the new moon day of *Māgha* begun, would be reckoned as the winter solstice day. The estimated winter solstice day for the beginning of the next year would be the 12th *tithi* of the coming *Māgha* and the first day of the sun's northerly course would be the 13th *tithi* of *Māgha* and in our gauge year 1929-30 A.D., it would correspond with the 11th February, 1930. Between the ending day of the battle (corresponding with January 1, 1930) and the first day of the sun's northerly course, there would intervene *41 days as predicted and not 50 days as observed.*

Thus judging by the methods of reckoning of the Vedic and post-Vedic followers of the five-yearly luni-solar cycles, it was not possible for an Indian astronomical assistant by any back calculation to furnish the *Mahābhārata* compiler of 400 B.C. with the set of astronomical references which we have used to establish that the Bhārata battle was fought in 2449 B.C.

Lastly, it may be contended that "the *Mahābhārata* writer of the 4th century B.C., while inserting the astronomical references merely calculated back on the assumption that the Great War was fought when *Pleiades* formed the vernal equinoxial point, because this was an older tradition."

We can here explore the possibilities of the above assumption in the following way:—The year of the *Brāhmaṇas* and the *Vedāṅgas* consisted of 366 days and a quarter-year was thus of 91·5 days. If the *Kṛttikās* or *Pleiades* were at the vernal equinox, then a full-moon at the *Kṛttikās* would be on the day of autumnal equinox, and the winter solstice day should come after 91·5 days according to this mode of reckoning. Now in order to interpret the *Mahābhārata* astronomical references we take a gauge year in which the full-moon of *Kārttika* took place very near to the *Kṛttikās*; this year would be 1934-35 A.D. The day of full-moon of *Kārttika* would correspond with 21st November, 1934. The predicted day of winter solstice would correspond with the *21st of February.* According to the *Mahābhārata* references, the anniversary of the last day of the Bhārata battle would be January 6, 1935 and of the winter solstice day the date would be the *25th February, 1935.* There would thus be a clear *difference of 4 days between the estimated winter solstice day and the*

Mahābhārata-stated winter solstice day.[1] Here if we take the *Mahābhārata* date for winter solstice to be correct, we get a total precession of the solstice-day amounting to 65 days, representing a lapse of 4810 years till 1935 A.D., and the date of the battle is pushed up to 2876 B.C., nearly, which gets no anchorage at either of the Āryabhaṭa or the Vṛddha-Garga tradition. Hence the above hypothesis cannot explain the possible finding of the *Mahābhārata* references as used in this chapter, by the epic compiler or his astronomical assistant of 400 B.C.

It is thus established that the *Mahābhārata* references used by us for finding the date of the Bhārata battle, cannot be taken as interpolation by the epic compiler of about 400 B.C. They were, in my opinion, the integral parts of the Pāṇḍava saga which formed the nucleus for the older *Mahābhārata* and the *Bhārata* and were finally included in the great epic when it was first formed about 400 B.C. These references have, therefore, been taken as really observed astronomical events or phenomena, made in the battle year itself and which were incorporated in the original Pāṇḍava saga.

CONCLUSION

We have thus come to the most definite conclusion that the Bhārata battle did actually take place in, – 2526 of Śaka era or 2449 B.C. For one single event only one date is possible. We trust, the problem of finding this date from the *Mahābhārata* data, has been satisfactorily solved in this work for the first time. The date arrived at makes the event as contemporary with the Indus valley civilization. In the *Mahābhārata,* we get many references to show that *Rākṣasas, Asuras* and the Aryan Hindus had their Kingdoms side by side. In *Vana-parva or* Book III, chapters 13 – 22 give us a description of the destruction of *Saubha Purī* by Kṛṣṇa. This may mean the destruction of a city like Mahenjo Dāro. The Bhārata battle was a pre-historic event and the Purāṇic dynastic lists relating to this period

[1] By the mean reckoning the number of days from the full-moon day of *Kārttika* to the 7th day of the dark half of *Māgha* × 29·5 × 3 + 7 = 95·5 days and 95·5 da. – 91·5 da. is also = 4 days.

cannot be taken as correct. They are mere conjectures and could be accepted only when they could be verified from other more reliable sources. There are undoubtedly several gaps in these lists, which have yet to be accounted for. In many cases, wrong traditions may be found repeated in many books; they all may be echoes of one statement and are not acceptable.[1] Not such are the *Mahābhārata* references which we have collected from the *Udyoga* to the *Anuśāsana parva*. We trust, my thesis stands on solid astronomical basis selected with the greatest care and discrimination. The misinterpretations of the commentator have been, on some occasions, confounding for a time.

The historical methods are often liable to very serious errors by wrong identification of persons from a similarity of names. The astronomer Parāśara, probably a man of the first and second centuries of the Christian era, was wrongly identified with Parāśara, the father of Vyāsa, the common ancestor of the Kauravas and the Pāṇḍavas, by the earliest researchers, Sir Wm. Jones, Wilford, Davis and Pratt.[2] They based their calculation on the statement of this Parāśara, the astronomer, as to the position of the solstices; their calculation has but given an approximate date of an astronomical event, but neither the time of the Pāṇḍavas nor of the astronomer Parāśara. Such mistakes have been made by many subsequent researchers, who have used the sameness or similarity of names as a basis for a historical conclusion. Not such are the astronomical references used in this paper. They are all definite in meaning and, as we have said already, for an event of which the date is not recorded in a reliable historical work, no better evidence of date is possible. Our examination in the light of these references fully corroborates the date recorded by Varāhamihira whose statement must now be regarded as more reliable than those of the host of the writers of the *Purāṇas* of unknown name and time.

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1 For a full discussion of Purāṇic evidences the reader is referred to Chapter III.

2 *Asiatic Researches*, Vol II, etc., *cf.* also JASB, for 1862 A.D., p. 51.
Also Brennand's Hindu Astronomy, Ch. IX, pp. 112-125.

A note on the selection of astronomical references from the Mahābhārata for

The Date of the Bhārata-Battle

In our selection of astronomical data in the present chapter no use has been made of those that are found in chapter 143 of the *Udyogaparva* and in chapter 3 of the *Bhīṣmaparva*.[1] I have understood them to be mere astrological effusions of bad omens; they are also inconsistent in themselves, and as such they cannot have any bearing as to the date of Bhārata-battle. These are :—

प्राजापत्यं हि नक्षत्रं ग्रहस्तीक्ष्णो महाद्युतिः ।
शनैश्चरः पीड़यति पीड़यन् प्राणिनोऽधिकम् ॥८॥
कृत्वा चाङ्गारको वक्रं ज्येष्ठायां मधुसूदन ।
अनुराधां प्रार्थयते मैत्रं संगमयन्निव ॥९॥
विशेषेण हि वार्ष्णेय चित्रां पीडयते ग्रहः ।
सोमस्य लक्ष्म व्यावृत्तं राहुरर्कमुपैति च ॥१०॥

Udyogaparva, 143.

"The planet Saturn which is acute (*tīkṣṇa*) and of great effulgence oppresses the star (*Rohiṇī* or *Aldebaran*) of which the presiding deity is Prajāpati, and causes great affliction to living beings. O slayer of Madhu (Kṛṣṇa), Mars having taken retrograde motion near to *Jyeṣṭhā* (or *Antares*) has now approached the star-group *Anurādhā* ('junction star' δ *Scorpionis*) or has already reached it of which the presiding deity is *Mitra*. More specially, O descendant of Vṛṣṇi, a planet troubles the star *Citrā* (α *Virginis*). The marks on the moon are changed and the node (*Rāhu*) is reaching the sun."

Here Saturn is indicated to have been in opposition; Saturn being near *Rohiṇī*, the sun must be near to the star *Jyeṣṭhā* (*Antares*). Again Mars is spoken of as in the *nakṣatra Anurādhā*

[1] See Appendix (V) to "An Indian Ephimeris, A.D. 700 to A.D. 1799 by Diwan Bahadur L. D. Swamikannu Pillai, I.S.O., pp. 479-83.

and is retrograde ; hence the sun must be nearly opposite to it and near to the star group *Kṛttikās* (*Pleiades*). The inconsistency of the statements is apparent. A planet which is not named is spoken of as have neared to α *Virginis*. All this is mere astrological effusion stating evil omens, and cannot have any chronological bearing. We next turn to another similar statement in the *Bhīṣmaparva*, chapter 3.

श्वेतो ग्रहस्तथा चित्रां समतिक्रम्य तिष्ठति ॥१२॥
धूमकेतुर्महाघोरः पुष्यं चाक्रम्य तिष्ठति ॥१३॥
मघास्वङ्गारको वक्रः श्रवणे च बृहस्पतिः ।
भगं नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते ॥१४॥
शुक्रः प्रोष्ठपदे पूर्वे समारुह्य विरोचते ॥१५॥
रोहिणीं पीडयत्येवमुभौ च शशिभास्करौ ।
चित्रास्वात्यन्तरे चैव विष्ठितः परुषग्रहः ॥१७॥
वक्रानुवक्रं कृत्वा च श्रवणं पावकप्रभः ।
ब्रह्मराशिं समावृत्य लोहिताङ्गो व्यवस्थितः ॥१८॥
संवत्सरस्थायिनौ च ग्रहौ प्रज्वलितावुभौ ।
विशाखायाः समीपस्थौ बृहस्पतिशनैश्चरौ ॥२७॥

" The white planet (Venus) stands by passing over the star *Citrā* (α *Virginis*). A dreadful comet is stationed at the star group *Puṣyā*. Mars retrograde is in the *Maghās*, and Jupiter in *Śravaṇā* division. The son of Sun (Saturn) oppresses the *nakṣatra Bhaga* (*P. Phalgunī*) by overtaking it. Venus in the *nakṣatra Proṣṭhapada* (*P. Bhādrapada*) shines there. Both the sun and moon oppress the star or *nakṣatra Rohiṇī*. A cruel planet is stationed at the junction of the *Citrā* and *Svātī nakṣatras*. The ruddy planet (Mars) looking like fire having got the even motion at *Śravaṇā* stands by overpowering the *nakṣatra* Brahmā. Stationed near the *Viśākhās*, both Jupiter and Saturn are seen burning as it were and would continue so for one year."

We tabulate below the positions of the planets in the two references :—

Planet	Position in Nakṣatra in Ref. I	Position in N. kṣatra in Ref. II	
Saturn	Rohiṇī	P. Phalgunī or Viśākhās	
Mars	Anurādhā	Maghā or Rohiṇī	
Sun	Jyeṣṭhā or Kṛttikā	Rohiṇī or Dhaniṣṭhā	(i.e., opposite to Maghā)
Moon	...	Rohiṇī	
Unnamed Planet	Citrā	Bet. Citrā & Svātī	
A-Node	Near to *Jyeṣṭhā*	...	
Venus	...	P. Bhādrapada or Citrā	
Jupiter	...	Śravaṇā or Viśākhā	

All this is hopelessly inconsistent astrological effusions of evil omens fit for Mother Goose's Tales only. Still something of chronology of the Bhārata battle was attempted by late Mr. Lele from them for which the reader in referred to Dīkṣita's **भारतीय ज्योतिःशास्त्र,** pp. 119-20 (1st edn.) ; the date arrived at by him was 2127 years before 3102 B.C.—a most fantastic result ! His finding of the positions of planets does not also agree with the abovementioned positions indicated in the *Mahābhārata* as explained already.

We again have the two statements :—

(*a*) राहुरग्रसदादित्यमपर्वणि विशाम्पते ॥१९॥

M.Bh., *Sabhā*, Ch. 79.

(*b*) राहुश्चाग्रसदादित्यमपर्वणि विशाम्पते ॥१०॥

M.Bh., *Śalya*, Ch. 59.

i.e., " Rāhu (also) eclipsed the sun, O king, when it was not a new-moon."

These statements are also mere poetic effusions. In *Bhīṣma parva*, Chapter III, we have another statement which says :—

चन्द्रसूर्यावुभौ ग्रस्तावेकमासीं त्रयोदशीम् ॥३२॥

" The moon and the sun were eclipsed in one month on the 13th day of either half."

We cannot put any faith in any statement of this chapter of the *Mahābhārata.* Two eclipses, one of the moon followed by the other of the sun in a fortnight, are not of very rare occurrence. In the year 2451 B.C. two such occurred :—

(1) On Aug. 30, 2451 B.C. at 18 hrs. G.M.T., or Kurukṣetra mean time 23 hrs. 8 min.

Mean Sun=137° 54′ 51″·56,	Hence there was a lunar eclipse on this day visible at Kurukṣetra, and it was of no small magnitude.
,, Moon=317° 28′ 47″·99,	
Lunar Perigee=101° 13′ 35″·60,	
,, A-Node=144° 37′ 5″·51,	
Sun's Apogee=27° 1′ 52″	
,, eccentricity=·018331	

Again on Sept. 14, 2451 B.C. at G.M.T. 0 hr. or 5-8 A.M. Kurukṣetra Mean Time:

Mean Sun=151° 57′ 35″·28,	This solar eclipse is discussed in a subsequent chapter. It was visible in the morning from Kurukṣetra.
,, Moon=145° 14′ 37″·54,	
Lunar Perigee=102° 48′ 50″·59,	
A-Node=143° 51′ 48″·96.	

Now on Aug. 16, 2451 B.C. at G.M.T. 0 hr. or K.M. time 5-8 A.M.

Mean Sun=123° 22′ 33″·69,	N.M. happened about 8 hours before.
,, Moon=123° 7′ 41″.32,	
L-Perigee=99° 35′ 0″·08,	
A-Node=145° 23′ 57″·36.	

Hence the N.M. happened on Aug. 15, at K.M. time 21-8 nearly. The moon was not visible on the 16th. The days of the month were reckoned from 17th or 18th Aug. 2451 B.C., the lunar eclipse fell on Aug. 30 and the solar eclipse on Sept. 14, 2451 B.C. The eclipses in question happened two years before

the date of the Bhārata battle as ascertained in this chapter, *viz.*, 2449 B.C.[1]

Note 2.—*Camparison of the Mahābhārata statements of Planetary positions with those calculated for 2449 B.C., the year of the Bhārata battle.*

In this connection we think it necessary to examine all the *Mahābhārata* statements of planetary positions at the different times of the year of the Bhārata battle, and compare them with the planetary positions in 2449 B.C. on the following dates:—(*a*) October 14, 2449 B.C., on the morning of which Kṛṣṇa met Karṇa as described in the *Udyoga-parva*, chapters 142 and 143 as quoted already on page 26; (*b*) November 3, 2449 B.C, *i.e.*, on the evening preceding the first day of the battle for which the planetary positions are stated in chapters 2 and 3 of the *Bhīṣma-parva* of which those in chapter 3 have been quoted on page 27; and (*c*) November 21, 2449 B.C. for which the planetary positions are found in chapter 94 of the *Karṇa-parva*. We now quote below one stanza from the *Bhīṣma-parva*, chapter 2, stating the position of Saturn, thus:

रोहिणीं पीडयन्नेष स्थितो राजन् शनैश्चरः ।
व्यावृत्तलक्ष्मसोमस्य भविष्यति महद्भयम् ॥३२॥

"O king, Saturn (the slow-going planet) stands oppressing the star *Rohiṇī* (*Aldebaran*) the moon's marks are reversed: great dangers are imminent."

Again in the *Karṇa-parva*, we have—

हते कर्णे सरितो न प्रसस्रुर्जगाम चास्तं सविता दिवाकरः ।
श्वेतो ग्रहश्च ज्वलनार्कवर्णः सोमस्य पुत्रोऽभ्युदियाय तिर्यक् ॥४९॥
बृहस्पतिः संपरिवार्य्य रोहिणीम् बभूव चन्द्रार्कसमो विशाम्पते ॥५१॥

Mah. Karṇa, 94, 49 and 51.

[1] In pages 482-83 of his work on "Indian Ephemeris." Dewan Bahadur L. D. Swamikannu Pillai, I. S. O., lends some support to the above finding of the date of the Bhārata battle—Mm. Sudhākara Dvivedī also accepted that the Bhārata battle was fought and the reign of Yudhiṣṭhira began in 2449 B.C., *vide* his edition of the *Mahā-Siddhānta*, Contents, pp. 1-8.

"When Karṇa was killed the streamlets ceased to flow and the sun set. The white planet (Venus) became of the colour of fire and Sun (combust or heliacally set?) and the son of Moon (*i e.*, Mercury) became heliacally visible obliquely."

"Jupiter surrounding the star *Rohiṇī* (*Aldebaran*) became as bright as the sun and the moon."

The planetary positions according to our calculations are exhibited below :—

Planet	October 14, 6 A.M. K. M. T.		Nov. 3, G. M. N or K. M. T., 17hrs. 8 mins.		Nov. 21, 6 A.M. K. M. T.	
	Longitudes of Planets.	Ref. stars with longs.	Longitudes of Planets.	Ref. stars with longs.	Longitudes of Planets	Ref. stars with longs.
Sun	181° 10′	δ Scorpii 181° 4′	202° 4′	λ Scorpii 203° 5′	219° 59′	σ Sagitter 220° 53′
Moon	85° 22′	α Leonis 88° 20′	3° 34′	α Tauri 8° 17′	237° 50′	α Aquila 240° 16
Mercury	199° 45′	λ Scorpii 203° 5′	215° 14′	δ Sagitter 213° 5′	199° 22′	λ Scorpii 203° 5′
Venus	176° 7′	δ Scorpii 181° 2′	200° 56′	λ Scorpii 203° 5′	223° 52′	σ Sagitter 220° 53′
Mars	144° 4′	α Virginis 142° 18′	157° 45′	α Libra 163° 35′	169° 33′	*i* Libra 169° 30′
Jupiter	11° 25′	α Tauri 8° 17′	8° 36	α Tauri 8° 17′	7° 56′	α Tauri 8° 17′
Saturn	357° 59′	η Tauri 358° 30′	356° 27′	η Tauri 358° 30′	355° 24′	η Tauri 358° 30′

As to Saturn, it is found twice stated that it was oppressing the star *Rohiṇī* (Aldebaran) of which the presiding deity is Brahma, the Creator or Lord of men. But the planet stands at a distance of about 10° from *Aldebaran*. The distance for the aspect of "oppression" is perhaps acceptable. As to Jupiter it was throughout retrograde and stood near to the star *Aldebaran*. Mars's progress extends from the star *Citrā* (α *Virginis*) to that of Viśākhā (i *Libra*). The planet is called "paruṣa" or cruel in chapter 3 of the *Bhīṣma-parva* and in Chapter 142 of the *Udyoga-parva* where it is spoken of as "oppressing" the star *Citrā* or

α *Virginis*, but is not given any name. Venus stands throughout in the position of "Combust" or heliacal setting. Mercury was visible a little before the sunrise on Nov. 21, morning. On Nov. 3, at evening the moon is oppressing the stars *Rohiṇī*, while the sun standing at 202° 4′ may be taken to "oppress" another *Rohiṇī* which was *Antares* called also *Jyeṣṭhā* of which the longitude was 188° 16′ nearly. It seems that in the *Udyoga*, 143, the verses 8 and 10 speak the truth: and in *Bhīṣma*, 2, the stanza 32, and in *Bhīṣma*, 3, the stanza 17 alone, tell the correct positions. In the *Karṇa-parva*, 94, the verses quoted are verified by our calculations. The *Mahābhārata* statements of planetary positions are thus found to be full of "truths and fiction" and I trust, in our selection of data for the year of the Bhārata battle, we have been able to avoid "fiction" and to accept the true astronomical events on which our finding of the year as 2449 B.C., has been based.

The last but not the least important astronomical indication is that Yudhiṣṭhira was consecrated for the *Aśvamedha* sacrifice which was year-long and used to be begun with the beginning of spring (astronomical, when the Sun's longitude became 330°). The date in question is stated to be *Citrāpūrṇamāsa* (चित्रापूर्णमास) or the day of the full-moon near the star α *Virginis* or *Citrā*. Consistently with our finding the year of the *Bhārata* battle as 2449 B.C., the date for Yudhiṣṭhira's consecration for the *Aśvamedha* sacrifice becomes—

March 11, 2446 B.C., on which at G. M. N. or K. M. T. 17 hrs. 8 mins.

True Sun = 329° 42′ 27″ ,, Moon = 144° 35′ nearly α *Virginis* = 142° 23′	Astronomical spring begins in about 7 hrs. and F. M. in about 10 hrs.

This was the day of the full-moon which is spoken of in the *Aśvamedhaparva*, Ch. 72, thus:

चैत्र्यां हि पौर्णमास्यां तु तव दीक्षा भविष्यति ॥४॥

"Your consecration will be on the day of the full-moon at *Citrā* (α *Virginis*).

The beginning of the five-yearly luni-solar cycles or *yugas* of the *Vedāṅgas* is associated with the day of the winter solstice thus :—

'When the sun, the moon and the *nakṣatra Dhaniṣṭhā* (*Delphinis*) ascend the heavens together, it is the beginning of the *Yuga* (cycle), of the month of *Māgha* or *Tapas*, of the light half and of the sun's northerly course.'[1]

Again all Hindu calendars and the *Purāṇas*[2] say that the *Kaliyuga* began with full-moon day of *Māgha*. This *Kali*-beginning was quite different from the astronomical *Kali* epoch, the later started from the light-half of *Caitra*, *i.e.*, from Feb. 17-18, 3102 B.C. Judging by the beginning of the luni-solar cycles of the Vedāṅga period, we should identify the day of the winter solstice with the full-moon day of *Māgha*, in finding the beginning of the *Kaliyuga* which is mentioned in the *Mahābhārata* and the *Purāṇas*.

Now we assume that the *Purāṇic Kaliyuga* was started from the full-moon day of the *standard month of Māgha*, of which we have spoken before,[3] and that day was also the day of the winter solstice. We also understand that it is the same *Kali yuga* of which the reference is found in the *Mahābhārata* and the *Purāṇas*.

We agree to accept that this standard month of *Māgha* happened in our own time in 1924 A.D. from the 5th of February to the 5th of March, with the characteristics, *viz.*, that it began

1 स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ।
स्यात्तदादियुगं माघस्तपः शुक्लोऽयनं ह्युदक्॥
—*Yājuṣa Jyautiṣa*, 6.

2 वैशाखमासस्य तु या तृतीया नवम्यसौ कार्त्तिकशुक्लपक्षे।
नभस्यमासस्य तमिस्रपक्षे त्रयोदशी पञ्चदशी च माघे॥
एता युगाद्याः कथिताः पुराणैरनन्तपुण्यास्तिथयश्चतस्रः॥
—*Viṣṇupurāṇa*, III, 14, 12-13.

also
वैशाखस्य तृतीया या नवमी कार्त्तिकस्य च।
पञ्चदशी च माघस्य नभस्ये च त्रयोदशी।
युगादयः स्मृता ह्येते दत्तस्याक्षय्यकारिका॥
—*Matsya Purāṇa*, 17, 4-5.

3 *Vide* Chapter I, page 21.

with the New-moon at the beginning of the *Dhaniṣṭhā* cluster, had its Full-moon near the *Maghās* and the Last Quarter conjoined with *Jyeṣṭhā* or *Antares*.

Now according to our finding the year of Bhārata battle was 2449 B.C. and in so far as the moon's phases near to the fixed stars are concerned it was similar to 1929 A.D. [1] Hence 2454 B.C. was in the same way similar to 1924 A.D.

It was in 2454 B.C., on the 9th January, that a full-moon happened. At Greenwich mean noon or 5-8 p.m. Kurukṣetra time on that date the apparent longitudes were for

Sun = 269° 36′,
Moon = 86° 16′, nearly.

The moon was ahead of the sun by 176° 40′ nearly; and the full-moon happened in about 7½ hours at about 1° 15′ ahead of the star *Regulus* or *Maghā*. The sun reached the winter solstice 2½ hours later. The day of the winter solstice and the full-moon day were the same day according to *Mahābhārata* convention [2] of its ending with the sunrise.

Most likely the *Mahābhārata Kaliyuga* truly began from this year of 2454 B.C., 10th January, when the Pāṇḍavas were still on exile. The year of the Bhārata battle or 2449 B.C. marked the end of five-yearly cycle, was within the *sandhi* or junction of the *Dvāpara* and *Kali* ages. This *sandhi* was a period which was taken to last a hundred years, *i.e.*, till about 2354 B.C. most likely. During this period men were uncertain when the *Kaliyuga* began. Hence the year of Bhārata battle coming five years after 2454 B.C. was itself taken as the beginning of the *Kaliyuga*. The year of Kṛṣṇa's expiry coming 36 years [3] after the great battle and 41 years (=38+3) after 2454 B.C. was also a beginning of the *Kaliyuga*.[4] In these years also the day of the winter solstice was not much removed from the full-moon day

[1] The foregoing chapter, p. 12 *et seq.*

[2] *M Bh., Aśvamedha*, 44,2.

[3] *M. Bh., Mauṣala*, Ch. 1.

[4] यस्मिन् कृष्णो दिवं यातस्तस्मिन्नेव तदाहनि ।
प्रतिपन्नं कलियुगं.....................

—*Viṣṇu Purāṇa*, IV, 24, 110,

of *Māgha*. Hence followed a 'rule of the thumb' that in this period, whenever the standard month of *Māgha* should apparently return, the day of the full-moon was taken as the winter solstice day.

As an illustration of how the above 'rule of the thumb' was followed for predicting the winter solstice day in Pāṇḍava time, we have already considered the words of Kṛṣṇa as to the expected day of Bhīṣma's expiry in Chapter I.[1] We propose to discuss it again by back calculation.

It has been shown that the observed day of winter solstice must have been the same as the *Māgha* full-moon day of 9th to 10th January, 2454 B.C. After the completion of the five yearly luni-solar cycle in 2449 B.C., there was apparently a return of the standard month of *Māgha*. The full-moon fell on the 14th January, 2449 B.C. on which at G.M. noon :—

Appt. Sun = 274° 53′
,, Moon = 90° 39′ nearly.

Thus the full-moon happened about 8½ hrs. later. This 14th of January was the estimated day of the winter solstice for the year 2449 B.C., but it could not be the accurately determined solstice day. Now the Vedic year was of 366 days or 12 lunations *plus* 12 nights. If we count 366 days from January 14, 2449 B.C., we arrive at the estimated day of the winter solstice as January 14, 2448 B.C. The first day of the sun's northerly course (as estimated) would be January 15, 2448 B.C., as the day for Bhīṣma's expiry. Now the battle ended on the 21st November, 2449 B.C. The number of days between these dates becomes 55 days. But one day more was probably included in this period in the following way :—

We have shown in Chapter I, that in the year 2449 B.C., the calendar authorities of the Pāṇḍava time, most probably began the reckoning of the lunar month of *Pauṣa* from the 20th of November.[2] Hence between this date and the expected day of Bhīṣma's expiry, the 28th day of lunar Māgha to come, there would be 29·5+28=57·5 days (here the estimated day of winter

[1] *M. Bh., Śānti*, 51, 44, *loc. cit.*

[2] Chapter I, p. 19.

solstice was the 27th day of lunar Māgha and Bhīṣma was to expire on the following day). Now reckoning from the day on which the battle ended till this expected day of the sun's northerly course there would be 56 or 57 days. This would explain Kṛṣṇa's prediction about the expiry of Bhīṣma, most probably made on the date on which the battle ended or on the day following.

(e) *Evidence of the Mahābhārata Kali-reckoning*

A question may now be asked if there is any evidence that this *Mahābhārata Kali*-reckoning was current in India for some time. The following instances may be cited :—

(1) A verse quoted in a work named the *Laghu Bhāgavatāmṛta* by Rūpa Gosvāmī, thus speaks of the time when the Buddha was accepted as an incarnation of Viṣṇu [1] :—

'He was revealed when 2,000 years of the *Kaliyuga* had elapsed ; his form was of a brown colour, two-handed and bald-headed.'

Now the Buddha's Nirvāṇa took place according to the latest authorities at his age of eighty in 483 B.C.[2] He was thus born in 563 B.C., and began preaching the truth that came to him when he was thirty-five or about 528 B.C. Two thousand years before the Nirvāṇa year was the date 2483 B.C., and our finding of the year of the battle is 2449 B.C. Hence according to the rough statement quoted above a *Kali*-reckoning was started near about the year of the battle.

(2) Again all orthodox Bengali almanacs record that [3] in the *Kali* age, kings Yudhiṣṭhira, Parīkṣit, Janamejaya, Śatānīka, Vikramāditya and others of the *lunar* race, 120 in number, ruled for 3,695 years 3 months and 18 days till the Muhammadan conquest (of Bengal presumably, as it is essentially a Bengal tradition). The Sena dynasty of Bengal, which claimed its descent

[1] असौ व्यक्तः कलेरब्दसहस्रद्वितये गते ।
मूर्त्तिः पाटलवर्णास्य द्विभुजा चिकुरोज्झिता ॥

Quoted by Sir William Jones in his paper in the *Asiatic Researches*, Vol. II, p. 22.

[2] Perhaps the real Nirvāṇa year was 544 B.C.

[3] "कलौ युधिष्ठिरपरीक्षिज्जनमेजयशतानीकविक्रमादित्यप्रभृतयः विंशत्यधिकशतसंख्यकाः इन्दुवंशोद्भवा राजानः साष्टादशदिनत्रिमासाधिकपञ्चनवतिवर्षाधिकषट्त्रिंशच्छतसंख्यवर्षाणि व्याप्य राज्यं कृत्वा स्वरारूढाः । ततः साह्रा सोलतान..." etc.

from the lunar race, reigned independently in East Bengal for some years even after the conquest of West Bengal by Muhammad Ibn Bakhtiyar. If we count 3,695 years from 2449 B.C. we arrive at the year 1247 A.D. for the extinction of the Sena dynasty, and is very nearly true historically. Hence the *Mahābhārata Kali*-reckoning was started from the zero year of the Yudhiṣṭhira Era, the very year of the Bhārata battle.

We trust, further evidences as to this *Mahābhārata Kali*-reckoning have all been supplanted by the astronomical *Kali* years started by Āryabhaṭa I, in 499 A.D. So great was the fame of Āryabhaṭa I, as regards astronomy and reckoning time, that very few dared to contradict him. Ravikīrti, the famous writer of the Aihole inscription of Pulakeśīn II (634 A.D.), accepts Āryabhaṭa's finding of the year of the Bhārata battle in speaking of his time as 3,735 years elapsed from that event.[1]

To sum up: The *Mahābhārata* indeed says that the Bhārata battle was fought at the junction of the *Kali* and *Dvāpara* ages; but the *Mahābhārata Kali* age was different from the astronomical *Kali* age started by a back calculation by Āryabhaṭa I, in 499 A.D. The former *Kaliyuga* truly began from 2454 B.C. (10th January). Even the year of the Bhārata battle (2449 B.C.) was in itself a possible beginning of this *Kaliyuga*, starting from the 14th January, 2449 B.C. We have shown examples of the *Mahābhārata Kali*-reckoning that have continued up to the present time from some other sources. The astronomical *Kali*-reckoning is a mere astronomical fiction created by Āryabhaṭa I, for a definite astronomical purpose, is an unreal thing as it was unconnected with any real astronomical event, is the result of a back calculation based on incorrect astronomical constants. It never could have existed before 499 A.D. and thus cannot truly point out the time of any historical event prior to this date. Thus the Āryabhaṭa tradition that the Bhārata battle was fought in 3102 B.C. is totally indefensible—is a pure myth.[2]

[1] त्रिंशत्सु त्रिसहस्रेषु भारतादाहवादितः।
सप्ताब्दशतयुक्तेषु गतेष्वब्देषु पञ्चसु॥

—*Epigraphia Indica*, VI, pp. 11-12-

[2] *Cf.* Dr. Fleet's discussion about this Kali era in JRAS, 1911—pp. 479 *et seq.*, and pp. 675 *et esq.*

CHAPTER III

DATE OF THE BHĀRATA BATTLE

Bhārata-Battle Tradition (C)

2. *Purāṇic Traditions and Evidences*

Befoie we can consider the *Purāṇic* traditions and evidences as to the time of Bhārata battle, it is necessary for us to establish which of the *Purāṇas,* as we have them now, have the oldest strata in them and which the latest. In fact we have to settle which are to be believed and which not, or which were the originals and which the borrowers and interpreters. We have to think of :—

(a) *The Sequcnce of the Purāṇas*

The *Purāṇas* which apparently seem to throw any light as to the date of Bhārata battle are :—

(1) The *Matsya Purāṇa,*
(2) The *Vāyu Purāṇa,*
(3) The *Viṣṇu Purāṇa,* and
(4) The *Bhāgavata Purāṇa.*

In all these *Purāṇas* we have the records of some of the earlier positions of the equinoxes and solstices, which are mere traditions and were not true for the time of composition of these works. The latest positions of the solstices as given in these works may be some guide as to the real sequence of these *Purāṇas.* The *Matsya Purāṇa* says that the sun reached the southernmost limit in *Māgha* and nothernmost limit in *Śrāvaṇa.*[1] This is of the same type as of the *Jyautiṣa Vedāṅga* rule '*Māgha-śrāvaṇayo-*

[1] *Matsya Purāṇa*, 124, 44 and 50.

ssadā' [1] and this was true for about 1400 B.C. The same statement occurs also in the *Vāyu Purāṇa*,[2] together with the more definite statement as to the position of the solstices, *viz.*, that of the *nakṣatras* the first was *Śraviṣṭhā*.[3] A little later the *Vāyu Purāṇa* again says that the circle of constellations began from the *nakṣatra Śravaṇā*.[4] Hence the latest indication of the position of the winter solstice was true for about 400 B.C., and it is the same as in the present recension of the *Mahābhārata*.[5] Thus from the astronomical indications it appears that the *Matsya Purāṇa* has the oldest *Purāṇic* stratum, then comes the *Vāyu* in the same respect.

Another evidence which helps our finding is that both the *Matsya* and *Vāyu Purāṇas* are mentioned and quoted in the present recension of the *Mahābhārata*.[6] According to Pargiter,[7] of the *Vāyu* and *Matsya Purāṇas*, the *Matsya* gives the oldest version, *Vāyu* the next in so far as the dynastic lists of the *Kali* age are concerned. Hence our finding of the sequence of the *Purāṇas* has some support from Pargiter and so also from Dr. V. A. Smith. It must be clearly understood that we do not mean to say that the *Purāṇas* as a class of literature did not exist before the present *Matsya* and *Vāyu Purāṇas* began to be compiled. In the *Śatapatha Brāhmaṇa* or the *Bṛhadāraṇyaka Upaniṣat*,[8] we find the enumeration of different classes of literature in which the *Purāṇas* have a place. In the *Āśvalāyana Gṛhya-Sūtra*, the *Purāṇas* and *Gāthā-Nāraśaṃsīs* [9] are distinctly mentioned. We do not, however, know the names of the *Purāṇas* which were current in the age of the *Brāhmaṇas* or of the *Sūtras*.

[1] *Yājuṣa Jyautiṣa*, 7.

प्रपद्येते श्रविष्ठादौ सूर्याचन्द्रमसावुदक्।

सार्पार्धे दक्षिणार्कस्तु माघश्रावणयोः सदा ॥

[2] *Vāyu Purāṇa*, 50, 172 and 127.

[3] *Ibid.*, 53, 111-116. [4] *Ibid.*, 53, 119.

[5] *M. Bh.*, *Aśvamedha*, 44, 2; for discussion, *cf.* Chapter I, p. 1.

[6] *M. Bh.*, *Vana*, 187, 55; also *M. Bh.*, *Vana*, 191, 16.

इत्येतन्मात्स्यकं नाम पुराणं परिकीर्त्तितम्। वायुप्रोक्तमनुस्मृत्य पुराणमृषिसंस्तुतम्।

[7] Pargiter's *Kali Age*, Introduction, p. XX.

[8] *Bṛhadāraṇyaka Upaniṣat*, IV, 5, 11.

[9] *Āśvalāyana Gṛhya-Sūtra*, 3, 3, 1.

Now coming to the *Viṣṇu Purāṇa,* we find that it is the telling of Parāśara, the father of Vyāsa to one Maitreya during the reign of Parīkṣit,[1] the grandson of Arjuna. Thus Vyāsa being the grandfather of the Pāṇḍavas, Parāśara was the great-great grandfather of Parīkṣit. In the *Mahābhārata* itself Parāśara is nowhere described as taking part in the events of the Pāṇḍava time. Hence the story of the origin of the *Viṣṇu Purāṇa* conflicts with our sense of historical perspective.

Again coming to the latest position of the solstices as stated in the *Viṣṇu Purāṇa* we find that it says [2] that the sun turned north at the first point of *Makara* (*Capricorn*) and turned south at the first point of *Karkata* (*Cancer*). *Such a statement at a vital point at once should place the present recension of the Viṣṇu Purāṇa between 499 A.D. to 700 A.D.* Similar remarks apply to the *Bhāgavata Purāṇa* also.

We thus come to the conclusion that the oldest *Purāṇas* are the *Matsya* and *Vāyu*, and the *Viṣṇu* and the *Bhāgavata* the latest from a consideration of the astronomical indications in them. So when we attempt at finding the year of the Bhārata battle from the *Purāṇas*, we should place the greatest reliance on the *Matsya* and then on the *Vāyu* accounts. The *Viṣṇu* and *Bhāgavata* evidences should be considered as mere conjectures and misinterpretations of the *Matsya* texts and as such are least reliable. We now proceed on to consider the *Purāṇic* dynastic lists as given in the *Matsya Purāṇa*.

(b) *Purāṇic Dynastic Lists*

The *Purāṇic* dynastic lists apparently seem to maintain a continuous record from the year of the Bhārata battle down to the extinction of the Andhras. The accounts of these lists contain two sorts of statements, *viz.*, (1) in which the reign periods of the kings are severally stated, behind which there is apparently the character of real chronicling, and (2) the statements of the reign periods of the different dynasties made collectively, which are

1 *Viṣṇu Purāṇa*, IV, 20, 13; I, 1, 16.

2 *Ibid.*, II, 8, 28-30.

evidently the work of later summarizers. We shall consider chiefly the Magadhan dynasties, the first of which was the Bṛhadratha dynasty. The *Matsya* account reads as follows [1] :—

"Henceforward I will declare the Bṛhadrathas of Magadha who are Kings in Sahadeva's lineage in Jarāsandha's race, *those past*, *those existing* and *those again who will exist*; I will declare *the prominent amongst them*; listen as I speak of them."

The dynastic list is thus professedly incomplete as it contains only the names of chief kings and the durations of their rules. The narration next runs thus [2] :—

"When the Bhārata battle took place and Sahadeva was slain, his heir Somādhi became king in Girivraja ; he reigned 58 years.

[1] अत ऊर्ध्वं प्रवक्ष्यामि मागधा ये बृहद्रथाः ।
जरासन्धस्य ये वंशे सहदेवान्वये नृपाः ॥
अतीता वर्त्तमानाश्च भविष्याश्च तथा पुनः ।
प्राधान्यतः प्रवक्ष्यामि गदतो मे निबोधत ॥

[2] संग्रामे भारते वृत्ते सहदेवे निपातिते ।
सोमाधिस्तस्य दायादो राजाऽभूत् स गिरिव्रजे ॥
पञ्चाशतं तथाऽष्टौ च समा राज्यमकारयत् ।
श्रुतश्रवाश्चतुःषष्टिं समास्तस्यान्वयेऽभवत् ॥
अयुतायुस्तु षड्विंशद्द राज्यं वर्षाण्यकारयत् ।
चत्वारिंशत् समास्तस्य निरमित्रो दिवं गतः ॥
पञ्चाशतं समा षट् च सुक्षत्रः प्राप्तवान् महीम् ।
त्रयोविंशद्द बृहत्कर्म्मा राज्यं वर्षाण्यकारयत् ॥
सेनाजित् सम्प्रयातश्च भुक्त्वा पञ्चाशतं महीम् ।
श्रुतञ्जयस्तु वर्षाणि चत्वारिंशद्द भविष्यति ॥
महाबलो महाबाहुर्महाबुद्धिपराक्रमः ।
अष्टाविंशति वर्षाणि महीं प्राप्स्यति वै विभुः ॥
अष्टपञ्चाशतं चाब्दान् राज्ये स्थास्यति व शुचिः ।
अष्टाविंशत् समा राजा क्षेमो भोक्ष्यति वै महीम् ॥
सुव्रतस्तु चतुःषष्टिं राज्यं प्राप्स्यति वीर्य्यवान् ।
पञ्चविंशति वर्षाणि सुनेत्रो भोक्ष्यते महीम् ॥
भोक्ष्यते निर्वृतिश्चेमामष्टपञ्चाशतं समाः ।
अष्टाविंशत् समा राज्यम् त्रिनेत्रो भोक्ष्यते ततः ॥

In his lineage Śrutaśravas was for 64 years. Ayutāyus reigned 26 years. His successor Niramitra enjoyed the earth 40 years and went to heaven. Sukṣatra obtained 56 years. Bṛhatkarman reigned 23 years. Senājit is also gone after enjoying the earth 50 years. Śrutañjaya will be for 40 years, great in strength, large of arm, great in mind and prowess. Vibhu will obtain 28 years; Śuci will stand in the kingdom 58 years. King Kṣema will enjoy the earth 28 years. Valiant Suvrata will obtain the kingdom 64 years. Sunetra will enjoy the earth 35 years. And Nirvṛti will enjoy this earth 58 years. Trinetra will next enjoy the kingdom 28 years. Dṛḍhasena will be 48 years. Mahīnetra will be resplendent 33 years. Sucala will be king 32 years. King Sunetra will enjoy the kingdom 40 years. King Satyajit will enjoy the earth 83 years. And Viśvajit will obtain this earth and be 25 years. Ripuñjaya will obtain the earth 50 years."

Then the *Purāṇic* summarizer says [1] :—

"These sixteen kings are to be known as future Bṛhadrathas. Their life-time will exceed by twenty years (the normal span of life) and their kingdom will last 700 years."

As we shall see, that these 16 Kings are all named in the above lists form Senājit to Ripuñjaya, and the sum total of their rules comes up correctly to 700 years. The account is concluded by[2] :

चत्वारिंशत् तथाऽष्टौ च दृढ़सेनो भविष्यति ।
त्रयस्त्रिंशत्तु वर्षाणि महीनेत्रो प्रकाश्यते ॥
द्वात्रिंशत्तु समा राजा सुचलस्तु भविष्यति ।
चत्वारिंशत् समा राजा सुनेत्रो भोक्ष्यते ततः ॥
सत्यजित् पृथिवीं राजा त्र्यशीतिर्भोक्ष्यते समाः ।
प्राप्येमां विश्वजिच्चापि पञ्चविंशद् भविष्यति ॥
रिपुञ्जयस्तु वर्षाणि पञ्चाशत् प्राप्स्यते महीम् ।

1 षोड़शैते नृपाज्ञया भवितारो बृहद्रथाः ।
वर्षोविंशाधिकं तेषां राज्यं च शतसप्तकम् ॥

2 द्वात्रिंशति नृपा ह्येते भवितारो बृहद्रथाः ।
पूर्णं वर्षसहस्रं वै तेषां राज्यं भविष्यति ॥

The *Matsya* texts quoted above have been very carefully compiled from Pargiter's *Dynasties of the Kali Age*. In the translation also I have followed Pargiter.

"These future Bṛhadrathas will certainly be 32 kings in all, and their kingdom will last full thousand years indeed."

The list of these Bṛhadratha kings as named above may be made up as follows. It should be clearly borne in mind that there are gaps to be filled up in this list—the gaps which we do not know how to fill up:

'Past' Kings	Years of Rule	'Present' and 'Future' Kings	Years of Rule
Somādhi	... 58	Senājit	... 50
Śrutaśravas	... 64	Śrutañjaya	... 40
Ayutāyus	... 26	Vibhu	... 28
Niramitra	... 40	Śuci	... 58
Sukṣatra	... 56	Kṣema	... 28
Bṛhatkarman	... 23	Suvrata	... 64
Total Years of 'Past' Kings	267	Sunetra I	... 35
		Nirvṛti	... 58
		Trinetra	... 28
		Dṛḍhasena	... 48
		Mahīnetra	... 33
		Sucala	... 32
		Sunetra II	... 40
		Satyajit	... 83
		Viśvajit	... 25
		Ripuñjaya	... 50
		Total Years of 'Present' and 'Future' Kings	... 700

In the above list there are named 22 kings in all, but nowhere do we find a clear statement that any one king was the son of the king named before him or he was the father of the next king. On the other hand we have the introductory statement that these

were the chief kings of the line running from Somādhi, or that the list of kings is incomplete from the start to finish. The sixteen of the 'future' Bṛhadrathas named in the list were only those of extraordinary longevity. The total number of the 'future' Bṛhadrathas is again stated definitely to be 32 and that the total duration of their rule would be full 1,000 years. It is not possible to arrive at any definite conclusion as to the duration of the kingship of the Bṛhadrathas from such an incomplete list. In order to understand the statements of the *Purāṇic* summarizers we however take the incomplete list as complete and see what results we are led to. We have the series of dynasties as follows :—

		Total Years
(1)	Bṛhadrathas of Magadha from the year of Bhārata battle.	... 967
(2)	Pradyotas of Avanti[1]	... 173
(3)	Śiśunāgas of Magadha[2]	... 360
	Total[3] Years	... 1,500

Then came the accession of Mahāpadma Nanda who was the founder of the Nanda dynasty of Magadha which lasted, according to the *Purāṇas*, full 100 years.

Thus between the year of the Bhārata battle or of the birth of *Parīkṣit* to the accession of Mahāpadma Nanda, as worked out from the dynastic lists of the Purāṇas there was the interval of

[1] बृहद्रथेष्वतीतेषु वीतिहोत्रेष्ववन्तिषु ।

पुलिकः (पुनिकः) स्वामिनं हत्वा स्वपुत्रमभिषेक्ष्यति ॥

Here compare the *Viṣṇu* statement which makes Pulika the minister of the last Bṛhadratha Ripuñjaya.

[2] Here the collective statement runs thus :

शतानि त्रीणि वर्षाणि षष्टिवर्षाधिकानि च ।

शिशुनागा भविष्यन्ति राजानो क्षत्रबान्धवाः ॥

'The Śiśunāgas who were Kṣatriyas of an inferior class will reign for 360 years.'

[3] According to *Viṣṇu* and *Bhāgavata Purāṇas* the period of Bṛhadrathas is 1,000 years and that of the Pradyotas is 138 years and of the Śiśunagas 360 years. Thus the total comes up to 1,498 years.

1500 years nearly. This is in agreement with the following statement of the *Purāṇic* summarizer :—

यावत् परीक्षितो जन्म यावन्नन्दाभिषेचनम् ।
एवं वर्षसहस्रं तु ज्ञेयं पञ्चशतोत्तरम् ॥[1]

'From the birth of Parīkṣit to the accession of Mahāpadma Nanda, the interval is to be known as one thousand five hundred years.'

We should here be very careful to ascertain what the second half of the second line of the above verse was, according to the *Purāṇic* summarizer. The variant readings are "ज्ञेयं पञ्चदशोत्तरम्", "शतं पञ्चदशोत्तरम्", "ज्ञेयं पञ्चाशदुत्तरम्" and "ज्ञेयं पञ्चशतोत्तरम्". The very next stanza runs thus :—

पुलोमास्तु तथान्ध्रास्तु महापद्मान्तरे पुनः ।
अन्तरं च शतान्यष्टौ षट्त्रिंशत्तु समास्तथा ।
तावत् कालान्तरं भाव्यम् अन्ध्रान्तायाः प्रकीर्त्तिताः ॥

The substance of which is that between Mahāpadma and the extinction of the Andhras the time interval was 836 years. According to the dynastic lists the sum total of the durations works out as :—

Nandas	...	... 100 years
Mauryas	...	... 137 ,,
Śuṅgas	...	... 112 ,,
Kaṇvas	...	... 45 ,,
Andhras	...	... 460 ,,
		Total[2] 854 years

Here a difference of 18 years is inexplicable as we do not know how long Mahāpadma Nanda ruled.

Now the interval between the birth of Parīkṣit and Nanda's accession = 1500 years as shown before, and the interval between Nanda's accession and the end of Andhras = 854 years as shown

1 Pargiter has traced this reading in *cefMt.*, *bMt.*, *lnMt*, *blVs.* recensions according to his notation in his *Dynasties of the Kali Age*, p. 58.

2 According to *Viṣṇu* and *Bhāgavata Purāṇas* the total comes out to be 850 years.

above. Hence the time between the birth of Parīkṣit and the extinction of the Andhras becomes according to the *Purāṇic* =2354 years.

Now in the mode of reckoning time by the cycle of *Ṛṣis*, the constellation of the great-bear is taken to remain conjoined with one *nakṣatra* for hundred years. In 2354 years, the *Ṛṣis* (Great Bear) would be taken to pass over 23 *nakṣatras* and reach the 24th *nakṣatra*. This is thus stated in the verse [1] :—

सप्तर्षयो मघायुक्ताः काले पारीक्षिते शतम् ।
अन्ध्रान्ते तु चतुर्विंशे भविष्यन्ति मते मम ॥

'The seven *Ṛṣis* were conjoined with *Maghās* 100 years in Parīkṣit's time ; they will be in the 24th constellation (*nakṣatra*) according to my estimate at the end of the Andhras.'

Here we have a clear statement by the summarizer that between the birth of Parīkṣit and the extinction of the Andhras the interval was slightly less than 2400 years. Hence it is clear that the true intention of the *Purāṇic* summarizer, as to the interval between the birth of Parīkṣit and the accession of Mahāpadma, is that it was about 1500 years and the true reading of the second half of the second line of the verse in question is undoubtedly "ज्ञेयं पञ्चशतोत्तरम्."

We have now to consider the following *Viṣṇu* and *Bhāgavata* statements that—

(*a*) 'From the birth of Parīkṣit to the accession of Mahāpadma Nanda the time interval is to be known as 1015 (or 1050) years.[2]

(*b*) 'When the Great Bear will reach the *nakṣatra Pūrvāṣāḍhā*, the *Kali* Age will have ascendency from the time of Nanda.' [3]

These verses cannot be traced either to the *Matsya* or the *Vāyu* texts. They are at variance with the dynastic lists as given in the *Viṣṇu* and the *Bhāgavata Purāṇas*. Even Śrīdhara, the

[1] Pargiter's *Kali Age*, pp. 58-59.

[2] महापद्माभिषेकात्तु यावज्जन्म परीक्षित: । एवं वर्षसहस्रं तु ज्ञेयं पञ्चदशोत्तरम् ॥
Pargiters *Kali Age*, p 58.

[3] प्रयास्यन्ति यदा चैते पूर्वाषाढां महर्षय: । तदा नन्दात प्रभृत्येष: कलिर्वृद्धिं गमिष्यति ॥
Ibid., p. 61

great commentator of the *Viṣṇu Purāṇa*, could not reconcile these statements and in the second statement would substitute 'Pradyota', the first king of the Pradyota dynasty in place of 'Nanda.'[1] In these *Purāṇas* (*Viṣṇu* and *Bhāgavata*) the summarizers were crazy in their arithmetic, and the *Purāṇas* themselves were written most probably in the Gupta and post-Gupta periods, and are not at all trustworthy in so far as historical matter is concerned. The main aim of the composers or compilers of these *Purāṇas* was to inculcate Vaiṣṇavism or the Viṣṇu-cult and perhaps not to record any real history.

If we are to put any faith in the *Purāṇic* dynasty-lists and the *Purāṇic* summarizers, the date of the Bhārata battle becomes 1921 B.C. as follows:—

Interval between Parīkṣit and Nanda	=	1500 years
Duration of the Nanda dynasty	=	100 ,,
Accession of Chandra Gupta Maurya	=	321 B.C.
The total gives the year	=	1921 B.C.

but we cannot accept as correct these *Purāṇic* statements whether of the dynastic lists or of the *Purāṇic* summarizers. The Bṛhadratha dynastic list is incomplete, further there was probably one period of *interregnum* between the extinction of the Bṛhadrathas of Magadha and the rise of Pradyotas of Avantī.

Again if we take that the 'future' Bṛhadrathas reigned for full 1000 years and the past Bṛhadrathas for 300 years, the dynastic lists would make the interval between the birth of Parīkṣit and the accession of Nanda 1900 years taking the *interregnum* to have lasted 100 years. To this period we have to add 421 to have the year of the Bhārata battle, which would now stand at 2321 B.C. All such speculations are valueless or inconclusive when they are based on totally unreliable materials derived from the *Purāṇas*. By way of contrast we have shown already,

[1] *Cf.* "यावदिति। पञ्चशतोत्तरं वर्षसहस्रम्। पाठान्तरे परीक्षित्समकालं मागधसोममारभ्य रिपुञ्जयान्तं मागधानां सहस्राब्दत्वस्योक्तत्वात्। अनन्तरं प्रद्योतशिशुनागानां पञ्चशताब्दस्योक्तत्वात् सार्द्धसहस्रस्योक्तस्य व्याख्यानम्। वायुक्तेऽपि परीक्षिन्नन्दान्तरं सार्द्धसहस्रमेवेत्युक्तम्। यदा पूर्व्वाषाढ़ायां महर्षयः गमिष्यन्ति तदा प्रद्योतात् प्रभृति वृद्धिं गच्छतीत्यर्थः। Śrīdhara's commentary on the *Viṣṇu-Purāṇa*.

how neatly and directly the *Mahābhārata* astronomical references lead us to the real year of the Bhārata battle.

If the *Purāṇic* faulty dynastic lists may lead us to 2257 B.C., we should more readily and preferably accept 2449 B.C. as the true year of the Bhārata battle, since it is deduced from the *Mahābhārata incidental* statements, which are more definite and also consistent astronomically, and corroborated by the Vṛddha Garga tradition as recorded by Varāhamihira.

(e) *Further Purāṇic Evidences by the 'Position' of the Great Bear*

We now proceed to consider another alleged *Purāṇic* evidence which states the position of the Great Bear in Parīkṣit's time. To us the statement that the Great Bear remains in one *nakṣatra* for 100 years is meaningless ; still we have to make some attempt at understanding what the *Purāṇas* say about it. The *Purāṇic* description of the movement of the Great Bear runs thus[1] :—

'The two front stars of the Great Bear, which are seen when risen at night, the lunar constellation which is seen equally between them in the sky, the Great Bear is to be known as conjoined with that constellation 100 years in the sky. This is the exposition of the conjunction of the lunar constellations and the Great Bear. The Great Bear was conjoined with the *Maghās* in Parīkṣit's time 100 years.'[2]

The two front stars are the two pointers, *viz.* α and β *Ursae Majoris*. We are to draw two great circles, one through each of the pointers and both passing through the celestial pole of the time : these circles will cut the ecliptic in two points; between these two points the *nakṣatra* in conjunction with the Great Bear will be equally distinct. The Great Bear was conjoined with

[1] सप्तर्षीणाञ्च यौ पूर्व्वौ दृश्येते ह्युदितौ निशि
तयोर्मध्ये तु नक्षत्रं दृश्यते यत् समं दिवि ॥
तेन सप्तर्षयो युक्तास्तिष्ठन्त्यब्दशतं नृणाम् ।
नक्षत्राणामृषीणाञ्च योगस्यैतन्निदर्शनम् ॥
सप्तर्षयो मघायुक्ताः काले पारीक्षिते शतम् ।

Pargiter's *Kali Age*, p. 59.

[2] Pargiter's *Kali Age*, Translation on p. 75.

the *Maghās* (α, η, γ, ζ, μ and ϵ *Leonis*) in Parīkṣit's time according to the above *Purāṇic* statement. This means that the celestial pole of the time of Parīkṣit lay on the great circle passing through the central star of the *Maghās* (α *Leonis*) and the middle point of the arc joining α and β *Ursae Majoris*. The celestial pole moves in a small circle about the pole of the ecliptic of a mean radius of about 23° 30′. We have solved this problem and the time of this celestial event comes out to be 371 B. C. The above statement as to the alleged position of the Great Bear in Parīkṣit's time is also equivalent to this: that the right ascension of α *Leonis* was equal to the mean of the right ascensions of α and β *Ursae Majoris*. From Dr. Neugebauer's *Sterntafelen* (Leipzig, 1912) the time for the event becomes about 300 B. C. It should thus appear that the time indicated by this *Purāṇic* statement, as to the position of the Great Bear in Parīkṣit's time, belonged neither to Parīkṣit nor to this *Purāṇic* astronomer. It is absolutely valueless for our purpose. Any other interpretations, that may be sought to be given to this position of the Great Bear as stated in the *Purāṇas* in Parīkṣit's time, are not acceptable as they would be mere speculations.

Some say that *Saptarṣi* or Great Bear here means the solsticial colure; the compiler of the *Purāṇa* wants to say that the solsticial colure passed through the middle point of the line joining α and β *Ursai Majoris* at the time of Parīkṣit. According to the above interpretation the time of Parīkṣit stands at the neighbourhood of 1400 B. C. But according to the statements of the *Purāṇas*, the *Saptarṣi*-line passed not only through the middle point of α and β *Ursai Majoris*, but it also passed through the middle point of the *nakṣatra Maghā* at the time of Parīkṣit. So according to the *Purāṇas*, the finding of time is not to be done with the help of α and β *Ursai Majoris* alone, leaving aside the *nakṣatra* division *Maghā* or the star *Regulus*. On the other hand we can find out the time alone with the help of *Maghā*. It may be shown that the summer solstical colure passed through *Maghā* (*Regulus*) in 2350 B. C.; but as the middle point of the *nakṣatra Maghā* is at about 40′ east[1] of the star *Regulus*, the time when

[1] According to the division of the ecliptic into *nakṣatras* as is now accepted.

the solsticial colure bisected that *nakṣatra* division is 2398 B. C. which is very near to 2449 B. C. the year of the Bhārata battle as determined by us. We have already said that an exact determination of the time of any past event by the above method is not possible. It would be rather controversial and inconclusive if in interpreting any statement of the *Purāṇas* we take into account only a portion of it. We have shown before that the *Purāṇic* statement regarding the position of the Great Bear is valueless. The year 371 B. C., obtained from the position of the Great Bear, perhaps relates to the time when the *Matsya* and the *Vāyu Purāṇas* began to be compiled, which has no connection with the time of Parīkṣit.

We have thus most carefully examined the *Purāṇic* evidences as to the date of the Bhārata battle. We have established that the oldest *Purāṇic* strata are to be found in the *Matsya Purāṇa*, then comes the *Vāyu Purāṇa* in sequence of time. In so far as historical matter is concerned the *Viṣṇu* and *Bhāgavata Purāṇas* are not at all trustworthy. Even in the *Matsya Purāṇa*, the dynastic list of the Bṛhadrathas of Magadha is incomplete in that it states the names of the chief kings only and the durations of their rules. We have also seen that the *Purāṇic* summarizers really mean that the time interval between the birth of Parīkṣit and the accession of Mahāpadma Nanda was about 1500 years. The *Viṣṇu* and *Bhāgāvata* summarizers' statement that the same period was about a thousand years is not reliable as it contradicts the dynastic lists of these *Purāṇas*, cannot be traced to the *Matsya* and *Vāyu Purāṇas* and not acceptable even to the great scholiast Śrīdhara of the *Viṣṇu Purāṇa*. The incomplete dynastic lists of the *Matsya Purāṇa* properly interpreted may lead us to 2321 B. C. as the year of Bhārata battle. Any speculation with such faulty materials as the *Purāṇas* afford, can never lead to the real truth about the year of the Bhārata battle. On the other hand much better *data* have been derived by us from the Mahābhārata itself which directly lead us to 2449 B. C. as the Year of the Bhārata battle and this was the zero year of the Judhiṣṭhira era according to the Vṛddha Garga tradition. We have also given the most careful consideration

to the *Purāṇic* description of the position of the Great Bear in Parīkṣit's time. This only leads us to the year 371 B. C.—a most hopelessly absurd result. Hence the *Purāṇic* evidences taken as a whole are incomplete and cannot lead us to the real year of the Bhārata battle. We trust our interpretations of all these evidences would be found to be rational and compare favourably with those given by Pargiter,[1] Dev,[2] Ray,[3] Bose,[4] and others.

Thus in the previous chapter we have shown that the Ārya-bhaṭa tradition, *viz.*, 3102 B. C. as the year of the Bhārata battle, is wrong. In the present chapter we have also established that the *Purāṇic* evidences are all incomplete and inadequate for our purpose. The Mahābhārata references lead us directly to the year 2449 B. C. as the year of the great battle. The *Kaliyuga* which the *Mahābhārata* speaks of beginning from about the year of the Bhārata battle truly started from the 10th January, 2454 B. C. Even in the year of the battle (2449 B. C.) this *Mahābhārata Kaliyuga* may have begun from the 15th January. We may look for epigraphic evidences in this connection but none have been brought to light as yet. Let us hope that such may be discovered at no distant future, when only our finding may be finally tested. Till then our finding of the year of the Bhārata battle must be allowed to stand.

1 Pargiter's *Indian Historical Traditions—The date of the Bhārata battle.*

2 Dev in JRASBL, 1925.

3 Prof. J. C. Ray in भारतवर्ष for the Bengali year 1340, Nos. 3, 4 and 5.

4 Dr. G. S. Bose in his पुराणप्रवेश in Bengali.

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CHAPTER IV

VEDIC ANTIQUITY

Madhu-Vidyā or the Science of Spring

In our enquiry into the antiquity of the *Vedas*, we shall, as a first step, try to interpret the *Madhu-Vidyā* or the Science of Spring of the Vedic Hindus. It may be objected at the outset that the term *Madhu-Vidyā* may not really mean the Science of Spring as here translated. Our answer is that Madhu and Mādhava were the two months of spring of the Vedic tropical year.[1] Hence there is some justification for putting *Madhu-Vidyā* as equivalent to Science of Spring. I trust more reasons for this rendering into English of the word would be apparent with the development of this chapter

To every Hindu the following *Ṛcas* are well-known :—

Ṛg-veda, M. I, 90, 6-8.

मधुवाताऽऋतायते मधु क्षरन्ति सिन्धवः । माध्वीर्नः सन्त्वोषधीः ॥
मधुनक्तमुतोषसो मधुमत् पार्थिवं रजः । मधुद्यौरस्तु नः पिता ॥
मधुमान्नो वनस्पतिर्मधुमाँ अस्तु सूर्यः । माध्वीर्गावो भवन्तु नः ॥

'Sweetness is blown by the winds and sweetness is discharged by the rivers; may the herbs be full of sweetness to us. May the nights and twilights be sweet to us, may the dust of the earth be sweet, may the sky-father (Dyauspitṛ = Jupiter) to us be full of sweetness. May the trees be full of sweetness to us, may the sun be full of sweetness, may our kine be sweet to us.'

The *ṛṣi* here finds that with the advent of spring air becomes pleasant and the water of rivers delightful. This was the time for harvesting wheat and barley and he conjures up the herbs to

[1] 'मधुश्च माधवश्च वासन्तिकावृतू' ।

Taittirīya Saṁhitā, 4, 4, 11.

yield him sweetness in the shape of a bumper crop. He expects the nights and twilights to lose the chillness of winter and be pleasant to him, and even the dust of the earth is to lose the cold touch of winter. He expects, the benign sky would yield him timely rain. The trees (then bearing flowers), the sun, the cattle are all to become full of sweetness.

The elements which bring him happiness or sweetness are:— (1) the winds, (2) the rivers, (3) the herbs, (4) the nights, (5) the twilights, (6) the earth, (7) the kindly sky bringing in timely rain, (8) the trees, (9) the sun, and (10) the cattle.

In the *Bṛhadāraṇyaka Upaniṣat*, II, 5, 1—14, the elements bringing in sweetness or *Madhu* to all beings are elaborated and enumerated as: (1) the earth, (2) water, (3) fire, (4) the winds, (5) the sun, (6) the cardinal points of the horizon, (7) the moon, (8) lightning, (9) thunder, (10) the sky, (11) right action, (12) truth, (13) humanity, and (14) the self. Here the connection of the elements with the coming of spring is quite forgotten, but it is remembered that the *Madhu-vidyā* or the science of spring was discovered by Tvaṣṭṛ from whom it passed to Dadhīci who revealed this science to the Aśvins after they had replaced the head of Dadhīci with the head of a horse. This story was revealed to the *ṛṣi* Kakṣīvān according to the *Bṛhadāraṇyaka Upaniṣat*.

The first verse quoted in this *Upaniṣat* is the *ṛc*. M. I, 116, 12 and runs as follows:—

तद्वां नरासनेयदंस उग्रम् आविष्कृणोमि तन्यतुर्नं वृष्टिम् ।
दध्यङ् ह यन्मध्वाथर्वणो वाम् अश्वस्य शीर्ष्णा प्रयदीमुवाच ॥

'As thunder announces rain, I proclaim, leaders, for the sake of acquiring wealth, that great deed which you performed, when provided by you with the head of a horse, Dadhyañc, the son of Atharvan taught you the science of *Madhu* (*i.e.*, spring).'

The next verse quoted by the *Upaniṣat* is *Ṛg-veda*, M. I, 117, 22, which is:—

आथर्वणायाश्विना दधीचेश्व्यं शिरः प्रत्यैरयतम् ।
स वां मधु प्रवोचदृतायं त्वाष्ट्रं यद्दस्रावपि कक्ष्यं वाम् ॥

'You replaced, Aśvins, with the head of a horse, (the head of) Dadhīci, the son of Atharvan, and true to his promise he revealed to you the science of *Madhu* (spring) which he had learnt from Tvaṣṭṛ and which was a jealously guarded secret.'

These lines from the *Ṛg-veda* suggest to us that the science of spring or *Madhu-vidyā* was nothing but the knowledge of the celestial signal for the coming of spring. What that signal was is now the matter for our consideration.

The Aśvins are always spoken of and addressed in the dual number. The Vedic *ṛṣis* most probably identified the Aśvins with the stars α and β *Arietis*—the prominent stars of the *nakṣatra Aśvinī*. Whether this be true or not, this much is certain that the Aśvins were and are even now regarded as the presiding deities of this *nakṣatra Aśvinī*. The three stars α, β and γ *Arietis* form a *constellation which is likened to the head of a horse.*[1] The Aśvins are spoken of as riding in the heavens in their triangular, three-wheeled and spring-bearing Chariot, in several places in the *Ṛg-Veda*, some of which are:—

(1) त्रयः पवयो मधुवाहने रथे सोमस्य वेनामनु विश्व इद् विदुः ।

M. I, 34. 2

'Three are the solid wheels of your *spring-bearing* (*Madhu-Vāhana*) chariot, as all the gods knew it to be when you attended on Venā (=Venus ?) the beloved of Moon.'

(2) अर्वाङ् त्रिचक्रो मधुवाहनो रथो जीराश्वो अश्विनोर्यातु सुष्टुतः ।
त्रिवन्धुरो मघवा विश्वसौभगः शं न आवक्षद् द्विपदे चतुष्पदे[2] ॥

M. I, 157.3

'May the three-wheeled car of the Aśvins, which is the harbinger of spring (*Madhu-Vāhana*), drawn by swift horses, three canopied, filled with treasure, and every way auspicious, come to our presence and bring prosperity to our people and our cattle.'

[1] अश्वयोनिस्त्रिरश्व्यं ।

Śākalya Saṁhitā, II, 162.

[2] I am indebted to Prof. MM. Vidhuśekhara Śāstri, the Head of the Dept. of Sanskrit, Calcutta University, for this and the next reference from the *Ṛg-Veda*. I owe it to him also that the adjective 'मधुवाहन' 'Spring-bearing' is applied only to the car of the Aśvins and to the car of no other god in the *Ṛg-Veda*.

(3) प्रातर्युजं नासत्याधितिष्ठथः प्रातर्यावानं मधुवाहनं रथम् ।

M. X, 41. 2

'Ascend, Nāsatyas, your *spring-bearing chariot* which is *harnessed at dawn* and *set in motion at dawn*, etc.'

(4) क्व त्रीचक्रा त्रिवृतो रथस्य, क्व त्रयो वन्धुरो ये सनीळाः ।

M. I, 34. 9

'Where, Nāsatyas, are the three wheels of your triangular car. Where the three fastening and props (of the awning)?'

(Wilson)

(5) त्रिवन्धुरेण त्रिवृता सुपेशसा रथेनायातमश्विना ।

M. I, 47. 2

'Come Aśvins, with your three-columned triangular car.'

(Wilson)

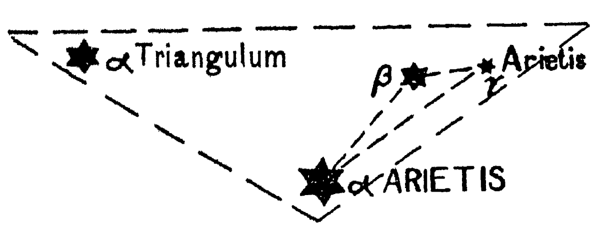
(6) त्रिवन्धुरेण त्रिवृता रथेन त्रिचक्रेण सुवृतायातमर्वाक् ।

M. I, 118. 2

'Come to us with your tri-columnar, triangular, three-wheeled and well-constructed car.' (Wilson)

All these references speak of the triangular, tri-columnar, three-wheeled car of the Aśvins. Here the three wheels of the car of the Aśvins were perhaps the three stars α, β, and γ *Arietis*, which constitute the *nakṣatra Aśvinī* likened to the head of a horse. Most probably the car of the Aśvins included one more star, α *Triangulum*, which with α and β *Arietis* formed a stable solid triangle as shown in the figure given below.

Aśvins' △ Car



The first three references speak of the car of the Aśvins as 'मधुवाहन' or *harbinger of spring*. The third reference directly

states that the car of the Aśvins which is '*spring-bearing*' is *harnessed at dawn* and *set in motion at dawn*. Inference is here irresistible that when the car of the Aśvins, *viz.*, the constellation Aśvinī consisting of the stars α, β and γ *Arietis* became first visible at dawn, the season of spring began at the place of observation which we shall take to be of the latitude of Kurukṣetra in the Punjab.

According to Wilson, the Aśvins were 'the precursors of the dawn, at which season they ought to be worshipped with libations of Soma juice.' There are of course many passages in the *Ṛg-Veda* which justify the above statement made by Wilson, but we desist from quoting them here as they only tell us that first rose the Aśvins, then came the dawn, and then rose the sun.[1] The season referred to here is that of the heliacal rising of the car of the Aśvins which brought in spring. The jealously guarded 'Madhu-Vidyā' or the 'Science of Spring' was thus nothing but the knowledge of the celestial signal for the advent of spring, and this was the heliacal rising of the stars α, β, γ, *Arietis*. Of these three, α *Arietis* rises last. Hence the Aśvins rise completely when α *Arietis* rises.

For the beginning of the Indian spring, the sun should have the tropical longitude of 330°. Hence when the star α *Arietis* became first visible at dawn it was the beginning of Indian spring with a celestial longitude of 330° for the sun—at a place in the Punjab of which the latitude was the same as that of Kurukṣetra (30° N). This furnishes sufficient data for the calculation of the time for this astronomical event. Now the dawn begins when the sun is 18° below the horizon. Thus at the time when α *Arietis* reached the eastern horizon with the sun at 18° below the horizon, *Madhu-Vidyā* was discovered or it was recognised

[1] Some of these references from the *Ṛg-Veda* are noted below :—
(*a*) युवोर्हि पूर्व्वं सवितोषसो रथम् ऋताय चि ' घृतवन्तमिष्यति । (M. I, 7, 4, 10) which means 'Before the dawn even, Savatri sends to bring you to the rite, your wonderful car shining with clarified butter.' (*b*) उषर्बुधः स्तोमो अश्विनावजीगः । (M. III, 5, 5, 1) *i.e.* 'the praiser awakes to glorify the Aśvins before the dawn.' These translations are due to Wilson. *Cf.* other references :— M. I, 5, 5; M. I, 6, 7; M. I, 9, 31, 4; M. I, 9, 4, 9; M. III, 5, 5, 1; M. VII, 4. 14, 5; M. VIII, 1, 5, 2.

One thing more that strikes us in this connection is that the so-called horse of Indra was most probably the constellation *Leo*, which is ordinarily likened to a lion. It may be likened to a horse as well, as in the above diagram:—

The stars ϵ, μ, *Leonis* forming the head of Indra's horse, the line joining γ and δ *Leonis* the back, α and θ *Leonis* the two legs, β *Leonis* the end of the tail. Indra in his car took his seat a little behind β *Leonis*.

As I have said before, in the first Chapter on '*Madhu-Vidyā*,' it has been established that when the first visibility of the Aśvins in the east was the signal for the advent of spring, the time was about 4000 B.C. These two Chapters show that about 4000 B.C the Vedic Hindus recognized the coming of the Indian spring and of the rains, by the heliacal risings of α *Arietis* and α *Leonis* respectively.

This practice is similar to that of the ancient Egyptians, of reckoning the year by the heliacal rising of α *Canis Majoris* or *Sirius*. In Homer's *Iliad*, we find in Bk. V, that this star *Sirius* is called "the summer star which shines very brightly," at least thus the translator interprets it. Again in *Iliad* Bk. XXII, is mentioned a 'star which rises in autumn' which people call the "dog of *Orion*." It seems that the same star *Sirius* was both the summer star and the autumn star in Homer's time. In such a case very probably the first visibility of the star at dawn showed the beginning of summer in Greece and the position of the same star higher up at dawn, the beginning of autumn.

It now appears that the practice of recognizing the seasons by the heliacal risings at some or other of the bright stars was followed by all ancient nations.

CHAPTER VI

VEDIC ANTIQUITY

Ṛbhus and Their Awakening by the Dog

In the preceding two chapters, we have spoken of the constellation of "the Car of the Aśvins" and of "the Horse or the Horses of Indra." In the present chapter we shall see who were the makers of the above constellations in the earliest Vedic times. The story of Dadhīci will also appear as mere allegory from what follows. The Ṛbhus, whose deeds we are going to describe here, were of the race of *Aṅgiras* and were exceptionally brilliant men of those times and while living they were entitled to the share of the sacrificial portion with the gods and after death they were supposed to be dwellers in the orb of the sun. The first hymn of the Ṛg-Veda addressed to them is M. I. 20, and here the Ṛṣi is Medhātithi, and runs as follows[1] :—

1. "This hymn, the bestower of riches, has been addressed by the sages, with their own mouths,[2] to the (class of) divinities having birth."

2. "They who created *mentally* for Indra the horses that are harnessed at his words, have partaken of the sacrifice performed with holy acts."

Here the 'horses' of Indra may be a single-bodied but a two-headed horse, being represented by the constellation *Leonis*. An alternative interpretation would perhaps be that the two stars *Castor* and *Pollux* may have been taken for Indra's horses, while Indra (=Maghavan) had his seat at α *Leonis* (Maghā). This interpretation would be in harmony with the Greek tradition of

[1] अयं देवाय जन्मने स्तोमो विप्रेभिरासया । अकारि रत्नधातमः ॥१॥
य इन्द्राय वचोयुजा ततक्षुर्मनसा हरी । शमीभिर्यज्ञमाशत ॥२॥

—Ṛg-Veda, M. I. 20.

[2] This shows that this hymn was not actually composed by Medhātithi.

taking the stars *Castor* and *Pollux* as horsemen. Between α *Leonis* and the stars *Castor* and *Pollux*, there lies no bright ecliptic star. These two stars rise before α *Leonis*, the seat of Indra, on whose heliacal rising at Kurukṣetra the rains set in in those times. The next *ṛcas* of the hymn run as follows [1] :—

3. " They constructed for the Nāsatyas, a universally moving and easy car, and a cow yielding milk."

Here the " car of the Aśvins " was the star-group formed of the stars α, β and γ *Arietis* together with α *Triangulum*, of which α and β *Arietis* with α *Triangulum* formed the stable triangle, α, β and γ *Arietis* the head of the horse, while α a nd β *Arietis* were symbols for the Aśvins.

4. " The Ṛbhus, uttering unfailing prayers, endowed with rectitude and succeeding (in all pious acts) made their parents young."

As we are concerned with the deeds of Ṛbhus we quote only—

6. " The Ṛbhus have divided unto four the new ladle, the work of the divine Tvaṣṭṛ."

8. " Offerers (of sacrifices), they held (a mortal existence) ; by pious acts they obtained a share of sacrifices with the gods."

This hymn thus narrated the deeds of the Ṛbhus and the honoured position which they attained by those good deeds, *viz.*, privilege of having the sacrificial portion with the gods.

The next *ṛṣi* to bear witness to the above great deeds of the Ṛbhus was Kutsa in the hymns M. I. 110-11. The most significant *ṛcas* are the following :—

4. " Associated with the priests, and quickly performing the holy rites, they, being yet mortals, acquired immortality and the sons of Sudhanvan, the Ṛbhus, brilliant as the sun, became connected with the ceremonies of the year." [2]

[1] तक्षन्नासत्याभ्यां परिज्मानं सुखं रथं । तक्षन् धेनुं सबर्दुघाम् ॥३॥
युवाना पितरा पुनः सत्यमन्त्रा ऋजूयवः । ऋभवो विष्ट्यक्रत ॥४॥
उतत्यं चमसं नवं त्वष्टुर्देवस्य निष्कृतम् । अकर्त चतुरः पुनः ॥६॥
आधारयन्त वह्नयो भजन्त सुकृत्यया । भागं देवेषु यज्ञियम् ॥८॥

—Ṛg-Veda, M. I. 20.

[2] विष्ट्वी शमी तरणित्वं वाघतो मर्तासः संतोऽ अमृतत्वमानशुः ।
सौधन्वनाऽ ऋभवः सूरचक्षसः संवत्सरे समपृच्यन्त धीतिभिः ॥

M. I. 110, 4.

The above verse shows the great esteem and position which the Ṛbhus had won while living amongst the men of their time.

5. "Lauded by the bystanders, the Ṛbhus, with a sharp weapon, meted out the single sacrificial ladle, like a field (measured by a rod), soliciting the best libations, and desiring to participate of sacrificial food amongst the gods." [1]

6. "To the leaders (of the sacrifice), dwelling in the firmament, we present, as with a laddle, the appointed clarified butter and praise with knowledge those Ṛbhus, who, having equalled the velocity of the protector (of the universe, the sun), ascended to the region of heaven, through the offerings of sacrificial food." [1]

Here the Ṛbhus are described as have ascended the orb of the sun by the merit of having offered the sacrificial food to the gods. We shall have further accounts of their life after death as understood by Dīrghatamas and Vāmadeva.

"The Ṛbhus, possessed of skill in their work, constructed for the Aśvins a well-built car; they framed the vigorous horses bearing Indra; they gave youthful existence to their parents; they gave to the calf its accompanying mother." [2]

We next pass on to the hymns of Dīrghatamas of M. I. 161, the *ṛcas* 6, 11 and 13.

"Indra has caparisoned his horses: the Aśvins have harnessed their car: Bṛhaspati has accepted the omniform cow: therefore, Ṛbhu, Vibhvā and Vāja go to the gods, doers of good deeds, enjoy your sacrificial portion." [3]

Here the import is that Indra begins to function or that the rains set in, when the constellation *Leonis* or Indra's horse rises heliacally, and that the rising in the same way of the car of the Aśvins brings in spring, and Bṛhaspati or Jupiter has been

[1] क्षेत्रमिव विममुस्तेजनेनँऽ एकंपात्रमृभवो जेहमानं। उपस्तुताऽ उपमं नाधमानाऽ अमर्त्येषु श्रवऽ इच्छमानाः ॥ आमनीषामंतरिक्षस्य नृभ्यः स्रुचेव घृतं जुहवाम विद्मना। तरणित्वायेपितुरस्य सश्चिरऽ ऋभवो वाजमरुहं दिवोरजः ॥

M. I. 110, 5 and 6.

[2] तक्षन्रथं सुवृतं विद्मनापसस्तक्षन् हरी इन्द्रवाहा वृषण्वसू। तक्षन् पितृभ्यामृभवो युवद्वयस्तक्षन् वत्साय मातरं स चाभुवम् ॥

M. I. 111, 1.

[3] इन्द्रो हरी युयुजेऽ अश्विना रथं बृहस्पतिर्विश्वरूपामुपाजत।
ऋभुर्विभ्वावाजो देवाँऽ अगच्छत स्वपसो यज्ञियं भागमैतन ॥

M. I. 161. 6.

discovered as a wandering body in the sky (here called the omniform cow). These are indeed great deeds which entitled the Ṛbhus to enjoy the sacrificial portion with the gods. They were great as observers of the heavens who had discovered the celestial signals for the coming of the rains and of spring; they had also discovered the planet Jupiter.

"Ṛbhus, the leaders (of the rains), you have caused the grass to grow upon the high places; you have caused the waters to flow over the low places; for (the promotion of) good works: as you have reposed for a while in the dwelling of the unapprehensible (unconcealable more properly) sun, so desist not to-day from the discharge of this your function."[1]

We conclude that the Ṛbhus were also leaders of the rainy season, they slept for a while in the orb of the sun with the first bursting in of the Indian summer monsoons, *i.e.*, from the time of the summer solstice. Here the idea of sleep of the Ṛbhus at this time, formed the basis of the Purāṇic Hindu faith that Viṣṇu and other gods sleep during the entire period of the rains lasting for four months of the Indian rains. At the place of the first Aryan settlers, which we have taken to have been near Kurukṣetra, there was a clearing up of the sky for some time after this first bursting of rains. Here Dīrghatamas does not tell us how long the Ṛbhus sleep in the orb of the sun, but that so long as they sleep the sky remains cloudy and the grass grows on the high places and water is spread over the low places. In the next verse we are told that the Ṛbhus are awakened by the Dog—when the clearing up of the sky follows the first bursting of the monsoons.

"Ṛbhus, reposing in the solar orb, you inquire, 'who awakens us, unapprehensible (unconcealable) sun to this office of sending rain?' Sun replies 'the awakener is the Dog and in the year you again to-day light up this world.'"[2]

[1] उद्वत्स्वस्माऽ अकृणोतनातृणं निवत्स्वपः स्वपस्यया नरः ।
अगोह्यस्य यदसस्तनागृहे तदद्येदमृभवो नानु गच्छथ ॥

M. I. 161, 11.

[2] सुषुप्वांसऽ ऋभवस्तदपृच्छतागोह्यकऽ इदं नोऽ अबूबुधत् ।
श्वानं बस्तो बोधयितारमब्रवीत् संवत्सरऽ इदमद्या व्यख्यत ॥

M. I. 161, 13.

Here the sun is taken to exhort the Ṛbhus reposing in his orb to clear up the sky on the call of the Dog. We are inclined to take, that this call of the Dog means the heliacal rising of the Dog-star or α *Canis Majoris*, *Sirius* or the *Sothis* which was the Egyptian name of the star.

We next pass on to the following *ṛc* by Vāmadeva.

"When the Ṛbhus, reposing for twelve days, remained in the hospitality of the unconcealable sun, they rendered the fields fertile, they led forth the rivers, plants sprung upon the waste and waters spread over the low places."[1]

From this statement it appears that in Vāmadeva's time, the Ṛbhus were taken to sleep for 12 days in the orb of the sun when they were awakened by the rising of the dog-star.

Hence we conclude that in Vāmadeva's time the heliacal rising of the dog-star took place twelve days after the sun reached the summer solstice. Now on the basis arrived at above, we determine the time of Vāmadeva as shown below, supposing that he also lived at the latitude of Kurukṣetra (30°N).

At the time we are going to determine, the heliacal rising of *Sirius* (α *Canis Majoris*) took place, at the latitude of Kurukṣetra, twelve days after the sun had reached the summer solstice. So the sun's true longitude was then 90°+12° or 102° nearly and the star came on the eastern horizon when the sun was 18° below it.

At the epoch 1931·0, the star α-*Canis Majoris* had its

R.A. = 6 h 42 m 6·524 s.

Dec. = −16°37′13″

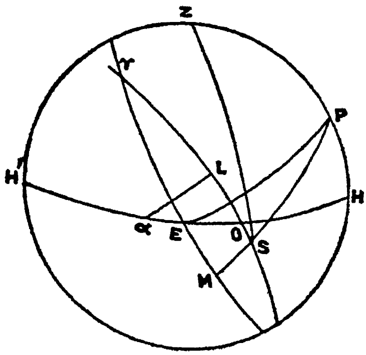
and the obliquity of the ecliptic ω = 23°26′54″

By transformation of the co-ordinates, we get:

Long. = 103°7′52″

Lat. = −39°35′24″, this latitude is supposed to remain nearly constant since the time of Vāmadeva.

[1] द्वादश द्यून्यदगोह्यस्यातिथ्ये रणन्नृभवः ससंतः ।
सुक्षेत्राकृण्वन्ननयंत सिन्धून् धन्वातिष्ठन्नोषधीर्निम्नमापः ॥ M. IV. 33·7,



Let the above figure represent the observer's celestial sphere at the latitude of Kurukṣetra (30°N). Here HPZH′ is the observer's meridian. HOEαH′ the horizon, γEM the celestial equator and γLS the ecliptic. S, indicates the sun's position at 18° below the horizon and α is the point on the horizon where α *Canis Majoris* rose at that time. Z and P respectively denote the Zenith and the celestial pole of the observer.

Now the following quantities are known:—

γS = true long. of the sun = 102° ... ... (1)

∠EγS = obliquity of the ecliptic at the required epoch which is assumed to be about 2700 B.C. = 24°0′ ... ... (2)

In the triangle γSM, the above two parts are known and the ∠SMγ = 90°.

Hence the declination of the sun = SM = 23°27′N ... (3)

and the R.A. ,, ,, = γM = 103°6′ ... ... (4)

Now in the triangle ZPS,

ZP = 60°, PS = 66°33′ and ZS = 108°.

The angle ZPS is given by

$$\tan\frac{ZPS}{2} = \sqrt{\frac{\sin\frac{ZS+PS-PZ}{2}\times\sin\frac{ZS+PZ-PS}{2}}{\sin\frac{ZS+PS+PZ}{2}\times\sin\frac{PS+PZ-ZS}{2}}},$$

whence we find the ∠ZPS = 129°46′. ... ... (5)

Subtract from it the ∠ZPE which is 90°, we find the angle MPE or the arc ME = 39°46′ ... ... (6)

Again γE = γM − ME = 103°6′ − 39°46′ = 63°20′ ... ... (7)

Now in the triangle γEO, $\gamma E = 63°20'$,

$$\angle E\gamma O = 24°,\ \angle OE\gamma = 90° + 30° = 120°.$$

So the other arc γO is found from

$$\cot\gamma O \times \sin\ 63°20' = \cos 24° \times \cos 63°20' - \tan 30° \times \sin 24°.$$

Put $\tan\phi = \dfrac{\tan 30°}{\cos 63°20'}$, whence $\phi = 52°8'{\cdot}5$

$$\therefore \cot\gamma O \times \sin 63°20' = \frac{\cos 63°20' \times \cos(52°8'{\cdot}5 + 24°)}{\cos 52°8'{\cdot}5}$$

$$\therefore \cot\gamma O = \frac{\cot 63°20' \times \cos 76°8'{\cdot}5}{\cos 52°8'{\cdot}5}$$

Hence $\gamma O = 78°54'{\cdot}6$ ... ... (8)

Again from the same triangle

$$\text{Sin}\ \gamma OE = \frac{\sin 63°20' \times \sin 120°}{\sin 78°55'}$$

So the $\angle\gamma OE = 52°3'$. ... ... (9)

Lastly we come to the triangle αLO,

where $\alpha L = 39°35'{\cdot}4$ (latitude of the star)

$\angle\alpha OL = 52°3'$ end the angle at L is a rt. angle.

Hence $\sin OL = \tan\alpha L \times \cot\alpha OL$

$\therefore OL = 40°9'{\cdot}5$. ... ... (10)

Now from the results (8) and (10) we can easily find the longitude of the star at the required epoch, thus:—

$$\gamma O = 78°54'{\cdot}6$$
$$OL = 40°9{\cdot}5$$
$$\therefore \gamma L = 38°45'$$

= longitude at the required time.

Long. in 1931·0 A.D. = 103° 8′

,, at the epoch = 38°45′

∴ Increase in the celestial long. = 64°23′

As a first approximation the above increase in the celestial longitude of the star indicates a lapse of 4636 years up to 1931 A.D.

him the atmosphere, the spaces *(rajas)* were measured out ; by him the gods discovered immortality." [1]

" 8. The ruddy one examined *(vi-mṛś)* the all formed, collecting to himself the *fore-ascents* *(praruha)* and the ascents *(ruha)* ; having ascended the sky with great greatness, let him anoint thy kingdom with milk, with ghee." [2]

" 9. What ascents *(ruha)* fore-ascents *(praruha)* thou hast, what on-ascents *(āruha)* thou hast with which thou fillest the sky, the atmosphere, with the *brahman*, with the milk of them increasing, do thou watch over the people in the kingdom of the ruddy one." [3]

In the first of these three verses, the heavens are divided into (1) *svar*, (2) *nāka*, and perhaps also into (3) the atmosphere, and by the sun, it is stated that the spaces were measured out. Here by the word *svar* is meant the part of the celestial sphere between the two tropics and the remaining portion was named *nāka*.

In the second verse we have the words *ruha* and *praruha* which must mean respectively the northern and southern limits of the sun's ascent as estimated on the meridian. All these considerations lead us to think that the " line of Brahmā " of the *Atharva Veda* and the *Taittirīya Brāhmaṇa* was undoubtedly the winter solstitial colure passing through the star α *Pegasi*. Hence our finding the date of the earliest Vedic culture as 4000 B.C. finds a most unexpected corroboration from the tradition recorded in the above-mentioned Vedic literature. It shows clearly that the earliest of the Vedic Hindus, the Ṛbhus, were interested principally in the determination of the solstitial colures and not much so in finding the equinoxial colures. The mention of *Rohiṇī* as the first star in the Mahābhārata and the mention

[1] रोहितो द्यावापृथिवी अदृंहत्तेन स्वऽस्तभितं तेन नाकः ।
तेनान्तरिक्षं विमिता रजांसि तेन देवा अमृतमन्वविन्दन् ॥७॥

[2] वि रोहितो अमृशद्विश्वरूपं समाकुर्वाणः प्ररुहो रुहश्च ।
दिवं रूढ्वा महता महिम्ना सं ते राष्ट्रमनक्तु पयसा घृतेन ॥८॥

[3] यास्ते रुहः प्ररुहो यास्त आरुहो याभिरापृणासि दिवमन्तरिक्षम् ।
तासां ब्रह्मणा पयसा वावृधानो विशि राष्ट्रे जागृहि रोहितस्य ॥९॥

of the two *Rohiṇīs* in the *Taittirīya Saṁhitā* and the *Taittirīya Brāhmaṇa*, with a difference of exactly 180° of longitude, suggests that the determination of the vernal equinox by the ancient (Vedic) Hindus could not have happened before 3050 B.C. The Mahābhārata again speaks of the full moons at the *Kṛttikās* and the *Maghās*, and as these stars *Kṛttikā* (η *Tauri*) and *Maghā* (α *Leonis*) differ in longitude by almost exactly 90° degrees, the above statement points accurately to the positions respectively of the V. Equinox and the summer solstice of the date 2350 B.C. although perhaps determined about 2449 B.C., the date of the Bhārata battle which was also the date of the *Taittirīya Saṁhitā*, as it speaks of the *Kṛttikās* as the first *nakṣatra*.

I tried to interpret the *Atharva* reference quoted above in terms of the heliacal rising of α *Pegasi* with the sun at vernal equinox, conjoined with *Rohiṇī*, but this interpretation was found impossible astronomically.

In the Chapter on "Madhu-Vidyā or the Science of Spring," I have demonstrated that the Science of Spring was the knowledge that spring set in near about Kurukṣetra with the heliacal rising of the *Aśvinī* group of stars, *viz* , the stars α, β and γ *Arietis*. The date from this condition, I have shown, comes out to be 4000 B.C

The further confirmation of this finding of mine has also been found from the *Ṛg-Veda* itself. In M.I. 85, the verses 13-15 run as follows[1] :—

" Indra, with the bones of Dadhyañc, slew ninety times nine Vṛtras."

" Wishing for the horse's head hidden in the mountains, he found it at Śaryaṇāvat."

" The (solar rays) found on this occasion the light of Tvaṣṭṛ verily concealed in the mansion of the moving moon."............ ....(Wilson).

[1] इन्द्रो दधीचोऽस्थभिर्वृत्राण्यप्रतिष्कुतः । जघान नवतीर्नव ॥१३॥
इच्छन्नश्वस्य यच्छिरः पर्वतेष्वपश्रितं । तद्विदच्छर्यणावति ॥१४॥
अत्राह गोरमन्वतनाम त्वष्टुरपिच्यं । इत्था चन्द्रमसो गृहे ॥१५॥

I am idebted to Mrs. A.S.D. Maunder, F.R.A.S. for drawing my attention to these verses.

In Wilson's translation, the last verse should begin with " He " in place of " The (solar rays)." The first verse says that Indra slew his enemies called Vṛtras (*i.e.*, Clouds), with the thunderbolt made of the bone of the fictitious person Dadhyañc, as the tradition from the Purāṇas says. In the second verse Indra discovered that spring had just begun with the heliacal rising of the horse's head or Aśvinī cluster when he observed it from the lake Śaryaṇāvat which was near Kurukṣetra according to the commentator. In the third verse the occasion or the time of observation was when Tvaṣṭṛ (=the sun) was found (or rather inferred to be) at the expected place of the moon or the night in question was of a new-moon. It must be admitted that a new-moon night is the best for observing the heliacal rising of a star or star group. It is almost needless to repeat that I used the same data for arriving at the date 4000 B.C. in the chapter on *Madhu-Vidyā*.

In another place of the *Ṛg-Veda*, Indra is called *meṣa* (the ram)—M.I. 51,1 runs thus[1]:—

" Animate with praise that Ram, Indra, who is adored by many, who is gratified by hymns and is an ocean of wealth."...... ......Wilson.

In explaining why Indra is called a ram (*meṣa*), Wilson refers to a legend, in which it is narrated, that Indra came in the form of ram to the sacrifice solemnized by Medhātithi and drank the *Soma* juice.

Now the sacrificial year began with spring generally, hence Indra's coming to the sacrifice began by Medhātithi must mean the heliacal rising of *Aries* (rather the *Aśvinī* cluster at the head of the Ram) at the beginning of spring. This is therefore easily interpreted by the *Madhu-Vidyā*, and Medhātithi must be a very ancient ṛṣi, much anterior to Vāmadeva who flourished about 2760 B.C. as determined in a previous chapter.

It must be admitted that in the *Ṛg-Veda* we have the mention of the constellations *Meṣa* (Aries) and *Vṛṣabha* (Bull),[2]

[1] अभित्यं मेषं पुरुहूतमृग्मियमिन्द्रं गीर्भिर्मदता वस्वोऽअर्णवं।

[2] *Ṛg-Veda*, M. I. 116, 18.

which were quite forgotten or disused in the later Vedic times and also in the Vedāṅgas. I have not got the names of the other signs of Zodiac in the *Ṛg-Veda*; perhaps they were not all formed in those days. I have already pointed out the dropping of some other old constellations in the later Vedic literature, the *Vedāṅgas* and the *Mahābhārata*.

It is perhaps unmistakably established that the earliest date for the Vedic Hindu culture must be about 4000 B.C.

CHAPTER IX

VEDIC ANTIQUITY

The Solar Eclipse in the Ṛgveda and the date of Atri.

In the present chapter we propose to find the time of the solar eclipse described in the *Ṛg-Veda*, the time which was undoubtedly that of the *ṛṣi* Atri. who was the author of the hymn V, 40, 5-9. The first attempt at finding the date of this event was made by Ludwig [1] in May, 1885, with the assistance of the Viennese astronomer Oppolzer. Ludwig imagined that there were references to four eclipses of the sun in the *Ṛg-Veda*, *viz*., V, 40, 5-9; V, 33, 4; X. 138, 3a and X, 138, 4. I have examined all these references and my view is that only the first reference describes a real eclipse of the sun, the other three relate to the summer solstice day and the appearance of the clouds. Ludwig's paper was severely criticised by Whitney in 1885 under the caption "On Professor Ludwig's views respecting total eclipses of the sun as noticed in the *Ṛg-Veda*," in the JAOS XIII, pp. lxi-lxvi, for October of the same year. Whitney ends his discussion by making the following remark:

"There are many other versions and statements and inferences in Prof. Ludwig's paper to which serious exception might be taken; but it was best to limit the discussion to the main point had in view—namely to show that no result possessing even presumptive and provisional value as bearing on ancient Hindu chronology has been reached by his investigation."

We shall show that Prof. Ludwig's interpretation of the Ṛgveda reference was not correct as this present chapter is developed. Prof C. R. Lanman in the year 1893 wrote a paper

1 Paper published in *Sitzung berichte* of the Bohemian Academy of Science in 1885.

on *Ṛgveda* V, 40 and its Buddhist parallel in Festscrift Roth 187. Eclipse du Soliel par *Svarbhānu*, parallel *Saṁyukta Nikāya*, II, 1, 10, cited in Louis Renou's *Bibliographie Vedique*.

We can only say that such similarity of statements as to solar eclipses in the two works cannot establish that the Atri tradition was contemporary with the *Saṁyukta Nikāya* event. To settle chronology by a reference to a solar eclipse is a very difficult matter, no easy-going researches can be of any value. Without making further attempt at tracing all the different attempts made before by other researchers, we proceed to interpret the *Ṛgveda* reference V, 40, 5-9. The original Sanskrit *ṛca's* are :—

यत्त्वा सूर्य्यं स्वर्भानुस्तमसाविध्यादासुरः। अक्षेत्रविद् यथा मुग्धो भुवनान्यदीधयुः ॥५॥ स्वर्भानोरधयदिन्द्रमाया ऽअवोदिवो वर्तमाना ऽअवाहन्। गूह्ळं सूर्य्यं तमसापव्रतेन तुरीयेण ब्रह्मणा विन्ददत्रिः ॥६॥ मामामिमं तवसन्तमत्र ऽइरस्याद्रुग्धो भियसानिगारीत्। त्वं मित्रोऽअसि सत्यराधास्तौमेहावतं वरुणश्च राजा ॥७॥ ग्राव्णो ब्रह्मायुयुजानः सपर्य्यंन् कीरिणा देवान्नमसोपशिक्षण्। अत्रि सूर्य्यस्य दिवि चक्षुराधात् स्वर्भानोरपमाया ऽअधुक्षत् ॥८॥ यं वै सूर्य्यं स्वर्भानुस्तमसाविध्यदासुरः। अत्रयस्तमन्वविन्दन् नह्यन्येऽअशक्नुवन् ॥९॥

Wilson's translation runs as follows :—

"5. When O Sūrya, the son of *asura*, *Svarbhānu*, overspread (rather 'struck') thee with darkness, the worlds were beheld like one bewildered not knowing his place."

The second line perhaps is more correctly translated as, "the worlds shone lustreless like a confounded tactless person."

"6. When, Indra, thou wast dissipating those illusions of *Svarbhānu* which were spread below the sun, then Atri, by his **fourth sacred prayer** (*turīyeṇa brahmaṇā*), discovered (rather 'rescued') the sun concealed by the darkness impeding his functions."

Whitney explains that *Svarbhānu* means simply "sky-light." Whatever that may be, what interests us here is the phrase "*turīyeṇa brahmaṇā*." "by the fourth sacred prayer", as translated by Wilson after Sāyaṇa. Some say that this means a

quadrant or the fourth part of a graduated circle, which we cannot take to be correct. The use of the graduated circle, or its fourth part in Vedic times was an impossibility ; we could admit the validity of the interpretation if the event belonged to Brahmagupta's time (628 A.D.). Further it is a barren meaning throwing no light on any circumstance of the eclipse. As Wilson following Sāyaṇa translates the phrase as " by the fourth sacred prayer," we may take this to be the only correct interpretation. As the fourth prayer of the day, most likely belonged to the fourth part of the day, we interpret **that the eclipse in question was finished in the fourth part of the day.**

Again the phrase '*turīyeṇa brahmaṇā.*' may also be interpreted in a different way. The word '*brahman*' itself may mean the summer solstice day. In the *Śāṅkhāyana Āraṇyaka* (Keith's translation), the *Mahāvrata* day is spoken of as " This day is '*Brahman*' (I, 2) and again the same day is thus referred to, " *Brahman* is this day" (I, 18). In the *Jaiminīya Brāhmaṇa*, II, 409-10, we have मध्यतः संवत्सरस्य विषुवति महाव्रतम् उपयन्ति ; which means that the *mahāvrata* ceremony used to be performed on the *Viṣuvant* or the summer solstice day. We thus understand that "*turīyeṇa brahmaṇā*" means "by the fourth part of the summer solstice day." In other words, the eclipse in question was over in the fourth part of the summer solstice day itself. (Here "*turīyeṇa brahmaṇā=turīyeṇa kālena brahmadivasena.*" "*Brahman*" thus means the longest day of year, which seems quite natural).

"7. [Sūrya speaks] ; Let not the violater, Atri, through hunger, swallow with fearful (darkness) me who am thine ; thou art Mitra whose wealth is truth : do thou and the royal Varuṇa both protect me."

This verse seems to suggest that the eclipse in question although apprehended to be total was not so at the place of the observer. Atri is here spoken of as having saved the sun from total disappearance. The verse is perhaps an example of "wisdom or power after the event."

"8. Then the Brāhmaṇa (Atri), applying the stones together, propitiating the gods with praise, and adoring them with

reverence, placed the eye of *Sūrya* (sun) in the sky ; he dissipated the delusions of *Svarbhānu*."

Here Atri is alleged to have found out the instant of the end of eclipse by counting stones together—a practice which was continued even up to the time of Pṛthūdaka (864 A.D.).[1] Atri's placing the eye of *Sūrya* in the sky shows that the end of the eclipse was visible or the eclpse finished before sunset.

"9. The sun, whom the *asura* Svarbhānu enveloped (rather 'struck') with darkness, the sons of Atri subsequently recovered ; no others were able (to effect his release)."

As to the day of the year on which this eclipse took place, the *Kauṣītaki Brāhmaṇa*, (xxiv, 3, 4) throws clearer light :—

स्वर्भानुर्हासुरादित्यं तमसाविध्यत्तस्यात्रयस्तमौपजिघांसन्त एतं सप्तदशस्तोमं त्र्यहं पुरस्ताद्विषुवत उपायंस्तस्य पुरस्तात्तमोपजघ्नुस्तत् परस्तादशोददेतमेव त्र्यहमुपरिष्टाद्विषुवत उपायंस्तस्य परस्तात् तमोपजघ्नुस्तद्य एवं विद्वांस एतं सप्तदशस्तोमं त्र्यहमुभयतो विषुवन्तमुपायन्त्युभाभ्यामेव ते लोकाभ्यां यजमानाः पाप्मानपघ्नते तान्वै स्वरसामान इत्याचक्षते एतैर्हवा अत्रयः आदित्यं तमसोपस्पृण्वत तद्यदपस्पृण्वत तस्मात् स्वरसामान स्तदेतदृचाऽभ्युदितम् ।

यं वै सूर्य्यं स्वर्भानुस्तमसाविध्यदासुरः ।
अत्रयस्तमन्वविन्दन्नह्यन्ये अशक्नुवन् ॥ इति

Keith translates the passage as follows :—

"Svarbhānu, an Asura, pierced with darkness the sun ; the Atris were fain to smite away its darkness ; they performed, before the *Viṣuvant*, this set of three days, with *saptadaśa* (seventeen) *stoma*. They smote away the darkness in front of it ; that settled behind, they performed the same three day rite after the *Viṣuvant* ; they smote away the darkness behind it. Those who perform knowing thus, this three-day (rite) with the *Saptadaśa stoma* on both sides of the *Viṣuvant*, verily those sacrificers smite away evil from both worlds. They call them the *Svarasāmans* ; by them the Atris rescued (*apas-pṛṇvata*) the sun from the darknesss ; in that they rescued, therefore, are the *Svarasāmans*, This is declared in a *ṛc*.

[1] *Cf.* Calcutta University Publication of the *Khaṇḍakhādyaka*, with Pṛthūdaka's Commentary, page 16.

"The sun which Svarbhānu
The Asura pierced with darkness,
The Atris found it,
None other could do so."

We gather from this passage that the day on which the eclipse happened was the *Viṣuvant* day. Now the word '*Visuvant*,' according to the *Aitareya* and the *Kauṣītaki Brāhmaṇas*, meant the summer solstice day, as I have set forth elsewhere. The arguments may be summarised thus:—

According to the *Aitareya Brāhmaṇa*, the *Viṣuvant* and the *Ekaviṁśa* day was the same day, the day on which the gods raised up the sun to the *highest point* in the heavens, and that on this day the sun being held on either side by a period of 10 days (*Virāj*) did not *waver* though he went over these worlds. Or that the *Viṣuvant* was the true summer solstice day. The *Kauṣītaki Brāhmaṇa* also says that the sun starting northward from the winter solstice on the new moon day of Māgha, reached the *Viṣuvant* after six months. Thus according these two *Ṛg-Veda Brāhmaṇas* the *Viṣuvant* day meant the s. s. day only.

In the days of the *Taittirīya Saṁhitā* 2446 B.C. and the *Tāṇḍya Brāhmaṇa* (about 1700 B.C.), the word *Viṣuvant* came to mean the middle day of the sacrificial year begun from spring, or it became the day when the sun's longitude became 150°, *i.e.*, the beginning of the Indian autumn. Finally the same word came to mean about the time (1400 B.C.) of the *Vedāṅgas*,[1] the vernal or the autumnal equinox day. The question to settle is which of these three meanings should we accept for the correct interpretation of this *Ṛgvedic* reference. Hence in interpreting a *Ṛgveda* reference, we should take the word *Viṣuvant* as the summer solstice day only, as this is the meaning of it given by the *Ṛgveda Brāhmaṇas*. Another point that needs be clarified is to get at the rough time of Atri and the place of his observation of this eclipse. We shall use the Ṛgveda references alone.

As to Atri, there are many references in the *Ṛgveda*:
I, 51, 3 ; I, 112, 7 ; I, 116, 8 ; I, 119, 6 ; I, 139, 9 ; I, 180, 4 ; I, 183, 5 ; V, 73, 6-7 ; VII, 68, 5 ; VII, 71, 5 ;

[1] *Yajuṣa Jyautiṣam*, 23.

VIII, 35, 19 ; VIII, 36, 7 ; VIII, 37, 7 ; VIII, 42, 5 ; VII, 62, 3-8 ; X, 39, 9 ; X, 143, 1-3 ; X, 150, 5.

Some of them are cited below as evidence to show where and when Atri lived.

(*a*) I, 51, 3 addressed to Indra—

"Thou hast shown the way to Atri, who vexes his adversaries by a hundred doors." [1]

(*b*) I, 112, 7 addressed to the Aśvins—

"You rendered the scorching heat pleasurable to Atri." [2]

(*c*) I, 119, 6 addressed to the Aśvins—

"You quenched with *snow* (*himena*) for Atri, the scorching heat."[3]

(*d*) I, 116, 8, addressed to the Aśvins—

"You quenched with *cold* (*himena*), the blazing flames (that encompassed Atri), and supplied him with food-supported strength ; you extricated him, Aśvins, from the dark *cavern* into which he had been thrown headlong, and restored him to every kind of welfare." [4]

(*e*) I, 139, 9, addressed by Parucchepa to Agni, showing the high antiquity in which Atri lived.—

"The ancient Dadhyañc, Aṅgiras, Priyamedha, Kaṇva, Atri and Manu have known my birth" [5]

(*f*) I, 181, 4 to the Aśvins—

"You rendered the heat as soothing as sweet butter to Atri."[6]

(*g*) V, 73, 6-7 to the Aśvins :—

"Leaders (of rites), Atri recognized your benevolence with a grateful mind on account of the relief you afforded him, when,

[1] अपोतावत्रये शतदुरेषु गातुवित् ।

[2] तप्तं घर्ममोम्यावन्तमत्रये ।

[3] हिमेन घर्मं परितप्तमत्रये ।

[4] हिमेनाग्निं घ्रंसमवारयेथां पितुमतीमूर्जमस्माऽअधत्तं ।
ऋबीसे अत्रिम् अश्विनावनीतमुन्निन्यथुः सर्वगणं स्वस्ति ॥

[5] दध्यङ्हमे जनुषं पूर्वोऽअंगिराः प्रियमेधः कण्वोऽत्रिर्मनुर्विदुस्तेमे पूर्व्वेमनुर्विदुः ॥

[6] युवं ह घर्मं मधुमन्तमत्रये पोनच्चोदोहणीतमैषे ।

Nāsatyas, through his praise of you, he found the fiery heat innocuous." "Atri was rescued by your acts." [1]

From these quotations it would appear that Atri took shelter in a cave with a hundred doors or openings, where he felt scorching heat, which was allayed by a thaw of ice from the snow-capped top of the mountain peak, at the bottom of which this cave was situated. From the quotation *(e)*, we gather that Atri was a contemporary of Dadhyañc, Aṅgiras, Priyamedha, Kaṇva and Manu, was probably one of the first batch of Aryans to pour into the Punjab. The favour of the Aśvins which Atri is alleged to have received was at the time perhaps of the rising of *a Arictis* in the east at the end of evening twilight. For this astronomical event at about 4000 B.C. at the latitude of Kurukṣetra, the Sun's longitude comes out to have been 97° 54′, which was correct to about 8 days after the summer solstice—the time or part of the year which was quite favourable for the thaw of the Himalayan ice.

We may then conclude that Atri lived about the time 4000 B.C., in a cave of hundred openings at the bottom of a snow-capped peak either of the Himalayas or of the Karakoram range. Hence the eclipse of the sun spoken of in the hymn attributed to Atri, happened on the *Viṣuvant* or the summer solstice day either correctly ascertained or estimated, in the fourth part of the day of the meridian of Kurukṣetra.

1. Now the *Viṣuvant* day as correctly ascertained would be the true summer solstice day, as we have reasons to believe that its ascertainment was possible for the Vedic people. Next if we suppose that as the Vedic year was of 366 days, the S.S. day was estimated from an observational determination of it one year before, the estimated S.S. day would tend to fall on the day following the true S.S. day. Hence we have to understand that by the word *Viṣuvant, we are to understand either the true S.*

[1] युवोरत्रिश्चिकेतति नरा सुम्नेन चेतसा ।
घर्मं यद्वामरेपसं नासत्यास्ना भुरण्यति ॥
* * * *
यद्वां दंसोभिरश्विनात्रिर्नराववर्तति ॥

Solstice day or the day following it, if we suppose that both the winter and summer solstice days were truly determined by the Vedic calendar makers of those times.

2. Then again if we suppose that the W. Solstice day was correctly ascertained by observation as a new-moon day of *Māgha*, and the summer solstice day was always estimated, the so-called S.S. day of those times would have many variants. The *Kauṣītaki Brāhmaṇa*, the *Aitareya Brāhmaṇa* and the *Vedāṅgas* take the sun's northerly and southerly courses to be of equal durations. This is possible only when the sun's apogee has the longitude of 90° or 270°. In the actual case the variation is shown below :—

Year.	Half year from W. Solstice to S. Solstice.	Half year from S. Solstice to W. Solstice.
—4000 A.D.	187 days	178·24 days
—3000 A.D.	186·75 ,,	178·49 ,,
—2000 A.D.	186·10 ,,	179·14 ,,
—1000 A.D.	185·20 ,,	180·04 ,,

The following interpretations may consequently be put on the *Viṣuvant* day of Vedic literature :—

(*a*) If the eclipse happened about 4000 B.C., on the estimated S. Solstice day from an accurate determination of the W. Solstice day on a *Māgha*-new-moon day, in 2½ years (tropical) the number of days would correctly be = 917 or even 918 days: whereas according to the Vedic calendars the same period would comprise 915 days only. Hence *the estimated S. Solstice day would be 2 or 3 days before the true date.*

(*b*) If about 4000 B.C., the eclipse happened on the estimated S. Solstice day, under the same system of reckoning for 7½ years (tropical), the number of days in this period = 2744 days correct and in the Vedic calendar there would be 2745 days instead. Hence *the estimated S. Solstice day would be the day following the true S. Solstice day.*

Hence in looking for the solar eclipse on the *Viṣuvant* day as interpreted in 1 and 2 (*b*) above, we must take it to mean either the true summer solstice day or the day following it.

In the case 2(*a*) we shall have to look for the eclipse 2 or 3 days before the true S. Solstice day; in this case we would be content on pointing out the suitable eclipse or eclipses. The detailed study will be made in the other case only.

We begin with former cases which are the more important for many reasons set forth before.

Hence the solar eclipse we want to find the date of, must satisfy the following conditions:—

(1) It must have happened on the summer solstice day or on the day following and no other date is admissible.

(2) It must have been a central solar eclipse.

(3) It must have happened or rather ended in the fourth part of the day for the meridian of Kurukṣetra.

(4) It must have been observed from a cave at the foot of a snow capped peak either of the Himālayas or of the Karakoram Range.

(5) That at the place of Atri, the eclipse did not reach the totality.

(6) It must have happened between 4000 to 2400 B.C., neither earlier nor later, when the word *Viṣuvant* had its oldest meaning, *viz.*, the summer solstice day.

We now proceed to determine the central solar eclipse which must satisfy all the conditions enumerated above. We get at a central solar eclipse happening on the 21st July, 3146 B.C.

The *Kauṣītaki Brāhmaṇa* says that the sun turned north on the new moon of *Māgha*. This *Māgha* is not an ordinary month of *Māgha* as it comes every year, but it was the Vedic standard month of *Māgha*, which came in our times in the years 1924, 1927, 1932 and 1935, as has been shown in another place. I tried the months of *Māgha* of the years 1924, 1932, and 1935, but these did not lead to a central solar eclipse. The Vedic month of *Māgha* as it came in the year 1927 B.C., however, did yield the central solar eclipse on the 21st July, 3146 B.C.,

on the day following the summer solstice day in the following way:—

In the year 1927 A.D., the Vedic standard month of *Māgha* lasted from February, 2 to March, 3, half the Vedic lustrum or full 31 lunations after this date came the 3rd of September, 1929 A.D., on which day the new moon happened at about G. M. noon.

Now on the 3rd September, 1929, G.M.N., the sun's mean longitude from Newcomb's equation comes out to have been =162° 8′ 33″. Ignoring the sun's equation I assumed as a first step that this longitude was =90° at the year we want to determine. This shows a total shifting of the solstices by 72° 8′ 33″, representing a lapse of 5227 years till 1929 A.D. From which we get that the longitude of the sun's apogee was 12° 36′ 48″ at 51·98 centuries before 1900 A.D. The eccentricity of the sun's orbit was =·01858 nearly. Hence the sun's equation for the mean longitude of 90° was = −2° 5′ 9″ nearly. This equation is applied to the mean longitude of the sun at G.M.N. on the 3rd September, 1929, *viz.*, to 162° 8′ 32″. The result 160° 3′ for 1929 A.D. was =90° in the year we want to determine. This gives a total shifting of the solstice up to 1929 A.D. to be=70° 3′ nearly, indicating a lapse of 5074 years. Now since 5074=1939×2+160×7+19×4, and as 1939, 160 and 19 years are lunisolar cycles, it may be inferred that the number of elapsed years till 1929 A.D. does not require any change to make the year arrived at similar to 1929 A.D.

Now 5074 sidereal years=1853311 days
=5074 Julian years +32·5 days.

Hence the Julian date arrived at
= −3145 A.D. July, 20.
or =3146 B.C. July, 20.

Now on July, 20. 3146 B.C., G.M.N. (1)	and on July, 21, 3146 B.C., G.M.N. (2)
Mean Sun=91°51′ 48″·42	Mean Sun=92° 50′ 56″·75
Mean Moon=80°1′ 41″·45	Mean Moon=93° 12′ 16″·45
Moon's Node=270°21′ 25″·00	Moon's D. Node=90° 18′ 14″·37
Moon's Perigee=250°39′ 1″·02	Moon's Perigee=250° 45′ 42″·07

The sun and the moon's elements have been calculated back from the equations given by Newcomb and Brown, respectively, which have been taken as correct from 4500 B.C. up to the modern times.

The figures in column (2) show that on the 21st July, 3146 B.C., there was an annular eclipse of the sun, but this was not visible from the northern Punjab, and cannot be accepted as giving us Atri's time. This eclipse took place (1) on the day following the summer solstice, (2) in the 4th part of the day on the meridian of Kurukṣetra. We take this eclipse as the starting point for further calculations. We find that:—

The mean tropical year at 3146 B.C. = 365·2425084 days

The mean synodic month 3146 B.C. = 29·5305988 days

The mean motion of the moon's node

at this epoch = 69636″·6596 per tropical year.

The tropical revolution of the node for the

same epoch = 18·61127 tropical years.

The tropical revolution of the moon's perigee

at the epoch = 8·84527 tropical years.

In our calculations both backward and forward from this epoch, we cannot use the Chaldean saros as it does not contain an exact number of tropical years. We have to proceed as follows:—

We want to find only those central eclipses of the sun which happened on the same day (*viz.*, the summer solstice) of the tropical year.

Now,

$$(a)\quad \frac{\text{Tropical year}}{\text{Synodic month}} = 12 + \frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{18+}\cdots$$

The convergents are: $\frac{12}{1}, \frac{25}{2}, \frac{37}{3}, \frac{99}{8}, \frac{136}{11}, \frac{235}{19}, \frac{4366}{353}$.

The important luni-solar cycles in tropical years are 8, 11, 19, and 353, the lunations in them being 99, 136, 235 and 4366, respectively.

(*b*) The convergents to tropical semi-revolutions of the node in tropical years

$$=\frac{9}{1}, \frac{28}{3}, \frac{93}{10}, \frac{121}{13}, \frac{335}{36}.$$

Now from these last set of convergents we get,

456 years $=(335+121)$

$=(353+19\times5+8)$ years.

(1) $\therefore$ 456 years $=24\frac{1}{2}$ revols. of Node

$=5640$ lunations very nearly.

Again 456 years $=166551$ days

and 5640 lunations $=166552{\cdot}6$ days.

(2) 391 years $=(335+2\times28)$ years

$=(36+6)$ nodal half revolutions

$=21$ nodal revols.

$=(353+19\times2)$ years.

Again 391 years $=142810$ days

and 4836 lunations $=142810$ days.

(3) 763 years $=(335\times2+930)$ years $=41$ revols. of Node

$=(353\times2+19\times3)$ years $=9437$ lunations nearly.

Again 763 years $=278680$ days and 9437 lunations $=278680$ days.

From these we readily get the new set of cycles :—

372 tropical years $\begin{cases} =4601 \text{ lunations} \\ =20 \text{ revol.}-4^\circ01' \text{ of motion of the Node} \\ =42 \text{ revol.}+20^\circ \text{ of motion of Perigee} \end{cases}$

391 tropical years $\begin{cases} =4836 \text{ lunations} \\ =21 \text{ revol.}+3^\circ10' \text{ of motion of Node} \\ =44 \text{ revol.}+73^\circ32' \text{ of motion of Perigee} \end{cases}$

Longitudes of Sun

	A	B	C
Mean Sun =	92° 21′ 0″	92° 25′ 55″	92° 33′ 51″
Sun's apogee =	1 55 57	1 55 57	1 55 57
g = Sun's anomaly (Indian) =	90° 25′ 3″	90° 29′ 58″	90° 34′ 54″
−128′·977 Sin g =	−2° 8′ 58″	−2° 8′ 58″	−2° 8′ 58″
+1′·512 Sin 2g =	... −1	... −2	... −2
Apparent Sun =	90° 12′ 1″	90° 16′ 55″	90° 21′ 51″
Mean Var. per hour	...	2′ 27″·5	

Longitude of Moon

MEAN ARGUMENTS	A	B	C
l = Moon − Perigee =	346° 31′ 42″	347° 37′ 1″	348° 42′ 21″
$2l$ =	333 3 23	335 14 2	337 24 42
D = Moon − Sun =	357 46 46	358 47 43	359 48 40
2 D =	355 33 32	357 35 26	359 37 20
4 D =	351 7 4	355 10 52	359 14 40
l' = Sun − Sun's perigee =	270 25 3	270 29 58	270 34 54
F =	173 30 18	174 36 27	175 42 36
2F =	347 0 36	349 12 54	351 25 12
$2D-l$ =	9° 1′ 50″	9° 58′ 25″	10° 54′ 59″
$2D-2l$ =	22° 30 8	22 21 24	22 12 39
$2D-l-l'$ =	98 36 47	99 28 26	100 20 5
$2D+l$ =	342 5 14	345 12 27	348 19 40
$2D-l'$ =	85 8 29	87 5 28	89 2 27
$l-l'$ =	76 6 39	77 7 3	78 7 27
$l+l'$ =	256 56 45	258 7 0	259 17 15
$2F-l$ =	0 28 54	1 35 53	2 42 52
$2D-2F$ =	8 32 56	8 22 32	8 12 8
$4D-l$ =	4 35 22	7 33 51	10 32 20

Moon's Inequalities

	A	B	C
+22640 Sin l =	−5274″·3	−4855″·0	−4434″·0
+769 Sin $2l$ =	− 348·4	− 322·1	− 295·4
+4586 Sin $(2D-l)$ =	+ 719·8	+ 794·3	+ 868·5
−125 Sin D =	+ 4·8	+ 2·6	+ 0·4
+2370 Sin 2D =	− 183·5	− 99·6	− 15·6
− 669 Sin l' =	+ 669·0	+ 669·0	+ 669·0
+212 Sin $(2D-2l)$ =	+ 81·1	+ 80·6	+ 80·1
+206 Sin $(2D-l-l')$ =	+ 203·7	+ 203·2	+ 202·7
+192 Sin $(2D+l)$ =	− 59·1	− 49·0	− 38·8
+165 Sin $(2D-l')$ =	+ 164·4	+ 164·8	+ 165·0

		A	B	C
$+148 \sin (l-l')$	=	+ 143·7	+ 144·3	+ 144·8
$-110 \sin (l+l')$	=	+ 107·2	+ 107·7	+ 108·1
$-85 \sin (2F-l)$	=	− 0·7	− 2·4	− 4·0
$+59 \sin (2D-2F)$	=	+ 8·8	+ 8·6	+ 8·4
$+39 \sin (4D-l)$	=	+ 3·1	+ 5·1	+ 7·1
− ves	=	−5866·0	−5328·1	−4787·8
+ ves	=	+2105·6	+2180·2	+2254·1
Total	=	−3760.0	−3147·9	−2533·7
	=	−1° 2′ 40″·4	−0° 52′ 27″·9	−0° 42′ 13″·7
Mean Moon	=	90° 7 45·4	91° 13 38·3	92° 19 31·2
Moon on orbit	=	89° 5′ 5″·0	90° 21′ 10″·9	91° 37′ 17″·5
A. Node (Ω)	=	276 37 27·1	276 37 11·2	276 36 55·4
$F_1 = M - \Omega$	=	172° 27′ 37″·9	173° 43′ 59″·2	175° 0′ 22″·1
$2F_1$	=	344 55 15·8	347 27 58·4	350° 0 44·2
	=	−15° 4′ 44″	−12° 32′ 2″	−9° 59′ 16″
$-417 \sin 2F_1$	=	+0° 1′ 48·5	+ 0 1 30·5	+0° 1′ 12″·3
Moon on orbit	=	89° 5 5·0	90° 21 10·4	91° 37 17·5
Apparent Moon	=	89° 6 53·5	90° 22′ 40·9	91° 38′ 29″·8

Mean variation per hour ... 0° 37′ 54″1
Instant of conjunction is 9·8 mins. before B.
i.e. 9 hrs. 50 mins. A.M. G.M.T. or 2 hrs. 58 mins. P.M. Kurukṣetra time

Arguments for Latitude of Moon

		A	B	C
F_1	=	172° 27′ 38″	173° 43′ 59″	175° 0′ 22″
$2D-2F$	=	8° 32 56	8 22 32	8 12 8″
$F_1+2D+2F$	=	181 0 34	182 6 31	183 12 30
l'	=	270 25 3	270 29 58	270 34 54
F_1-l'	=	262 2 35	263 14 1	264 25 28
F_1+l'	=	82 52 41	84 13 57	85 35 15
l	=	346 31 42	347 37 1	348 42 21
F_1-l	=	185 55 56	186 6 58	186 18 1
F_1-2l	=	199 24 14	198 29 57	197 35 40
$F_1+2D-2F-l'$	=	270 35 31	271 36 33	272 37 36
$F_1+2D-1F+l'$	=	91 25 37	92 36 29	93 47 24
$F_1+2D-2F-l$	=	194 29 52	194 29 30	194 30 9

Latitude of Moon

	A	B	C
$+18518{\cdot}5 \text{ Sin } F_1 =$	$+2429''{\cdot}7$	$+2021''{\cdot}5$	$+1612''{\cdot}0$
$+528{\cdot}3 \text{ Sin } (F_1+2D-2F) =$	$-9{\cdot}3$	$-19{\cdot}4$	$-29{\cdot}6$
$-25{\cdot}0 \text{ Sin } (F_1-l') =$	$+24{\cdot}7$	$+24{\cdot}8$	$+24{\cdot}9$
$+23{\cdot}8 \text{ Sin } (F_1+l') =$	$+23{\cdot}6$	$+23{\cdot}7$	$+23{\cdot}7$
$+23{\cdot}2 \text{ Sin } (F_1-l) =$	$-2{\cdot}4$	$-2{\cdot}5$	$-2{\cdot}6$
$-23{\cdot}6 \text{ Sin } (F_1-2l) =$	$+7{\cdot}8$	$+7{\cdot}5$	$+7{\cdot}1$
$+22{\cdot}1 \text{ Sin } (F_1+2D-2F-l') =$	$-22{\cdot}1$	$-22{\cdot}1$	$-22{\cdot}1$
$-10{\cdot}4 \text{ Sin } (F_1+2D+2F+l') =$	$-10{\cdot}4$	$-10{\cdot}4$	$-10{\cdot}4$
$-15{\cdot}4 \text{ Sin } (F_1+2D-2F-l) =$	$+3{\cdot}9$	$+3{\cdot}9$	$+3\ 9$
+ves =	$+2489{\cdot}7$	$+2081{\cdot}4$	$+1671{\cdot}6$
−ves =	$-44{\cdot}2$	$-54{\cdot}4$	$-64{\cdot}7$
Total =	$+2445{\cdot}5$	$+2027{\cdot}0$	$+1606{\cdot}9$
∴ Latitude° =	$+42'\ 45''{\cdot}5$	$+33'\ 47{\cdot}0$	$+26'\ 46''{\cdot}9$

Mean variation per hour $= -3'\ 29''{\cdot}6$

Moon's horizontal parallax

$$P=3422{\cdot}''7+186''{\cdot}6 \cos l+10''{\cdot}2 \cos 2l+34''{\cdot}3 \cos (2D-l)$$

$$+28''{\cdot}3 \cos 2D+3''{\cdot}1 \cos(2D+l)$$

	B
$+186{\cdot}6 \cos l=$	$+182{\cdot}3$
$+\ 10{\cdot}2 \cos 2l=$	$+\ 9{\cdot}3$
$+\ 34{\cdot}3 \cos (2D-l)=$	$+\ 33{\cdot}8$
$+\ 28{\cdot}3$ oos cD=	$+\ 28{\cdot}3$
$+\ 3{\cdot}1 \cos (2D+l)=$	$+\ 3{\cdot}0$

Constant=3422·7

Hor. parallax=3679″·4=61′ 19″·4

Moon's Semi-diameter=16′ 42″·4

Sun's Semi-diameter=16′ 1″·4

Calculation of the eclipse for longitude of Kurukṣetra and latitude = 33°½ North.

	A	B	C
Mean Long. of Sun	= 92° 21′ 0″	92° 25′ 55″	92° 30′ 51″
Local time	= 1-8 P.M.	3-8 P.M.	5-8 P.M.
Local in degrees	= 17° 0 0	47° 0 0	77° 0 0
R. A. of meridian or Sidereal time	= 109° 21′ 0l′	139° 25 55	169° 30′ 51″

Obliquity of the ecliptic = 24° 6′ 15″

	A	B	C
Long. of culminating pt. of ecliptic	= 107° 46′ 25′′	136° 50′ 5″	168° 32′ 16″
Eclip. angle with meridian (θ′)	= 82° 13′ 23″	71° 55′ 36″	66° 19′ 23″
Dec. of cul. point	= +22° 53′ 11″	+16° 13′ 25″	+ 4° 39′ 18″
Lat. of place	= +33° 30′ 0″	+33° 30′ 0″	+33° 30′ 0″
Z. dist. of cul. pt. = ZC	= 10° 36′ 49″	17° 16′ 35″	28° 50′ 42″
Z. dist. of Nonagesimal = ZN	= 10° 31′ 9″	16° 23′ 58″	26° 13′ 18″
Parallax in lat.	= − 11′ 11″·8	− 17′ 18″·9	− 27′ 6″·0
Lat. of Moon	= + 40′ 45″·5	+ 33′ 47″·0	+ 26′ 46″·9
Corrected latitude	= + 29′ 33″·7	+ 16′ 28″·1	− 0′ 19″·1

	A	B	C
Z. dist. of nonagesimal = ZN	= 10° 31′ 9″	16° 23′ 58″	26° 13′ 1 8″
Z. dist. of cul. pt. = ZC	= 10° 36′ 49″	17° 16′ 35″	28° 50′ 42″
θ′	= 82° 13′ 23″	71° 55′ 36″	66° 19′ 23″
Cul. pt. − nonagesimal = CN	= 1° 27′ 9″	5° 30′ 40″	12° 28′ 19″
Culminating point	= 107° 46′ 25″	136° 50′ 5″	168° 32′ 16″

		A	B	C
∵ Nonagesimal	= N =	106° 19′ 16″	131° 19′ 25″	156° 3′ 57″
App. Sun	=	90° 12′ 1″	90° 16′ 55″	90° 21′ 51″
N − ⊙	=	16° 7′ 15″	41° 2′ 30″	65° 42′ 6″
ZN	=	10° 31′ 9″	16° 23′ 58″	26° 13′ 18″
Parall. in Long.	=	− 16′ 44″·4	− 38′ 37″·6	− 50′ 8″·4
Long. of Moon	=	89° 6 53·5	90° 22′ 40·9	91° 38′ 29″·8
Corrected Moon	=	88° 50′ 9″·1	89° 44′ 3″·3	90° 48′ 21″·4
App. Sun	=	90° 12 1	90° 16 55	90° 21 51
☽ − ⊙	=	−1° 21′ 52″	−0° 32′ 52″	+0° 26′ 30″
1st diff.	=	+49′ 0″	+59′ 22″	
2nd diff.	=		+10′ 22″	

∴ ☽ − ⊙ $= -0°32'52'' + (5411'')t + (5'11'')t^2 = \chi$

Where t is measured from B in units of 2 hrs.

Corrected latitude	=	+29′ 33″·7	+16′ 28″·1	−0′ 19″·1
1st diff.	=	−13′ 5″·6	−16′ 47″·2	
2nd diff.	=		−3′ 41″·6	

Corrected latitude $= 16' 28''\cdot1 - (14' 56''\cdot4)t - (1' 50''\cdot8)t^2 = \psi$

Sum of Semi-diameters = 1964″ (M + S)

Diff. of Semi-diameters = 41″ (M − S)

Kurukșetra mean time.	χ	ψ	$\sqrt{\chi^2+\psi^2}$		
3-8 P.M.	−1972″	+988″	2206″		
				−837	
3-38 ,,	−1140	+757	1369		
				−791	
4-8 ,,	−269	+512	578		
				+111	+1692
4-38 ,,	+640	+254	689		
				+901	-
5-8 ,,	+1590	−19	1590		
				+1005	
5-38 ,,	+2577	−305	2595		

Nearest approach of the centres of the Sun and the Moon occurs ·37 × 30 mins after 4-8 P.M., *i.e.*, at 4-19 P.M.

Minimum distance = 521″

Mag. of eclipse = ·735 = 8·8 Indian units.

$$\text{Time of beginning} = 3 \text{ hrs. } 8 \text{ mins.} + \frac{2206 - 1961}{837} \times 30 \text{ mins.}$$

$$= 3 \text{ hrs. } 8 \text{ mins.} + 9 \text{ mins.} = 3\text{-}17 \text{ P.M.}$$

$$\text{Time of ending} = 5 \text{ hrs. } 8 \text{ mins.} + \frac{1964 - 1590}{1005} \times 30 \text{ mins.}$$

$$= 5 \text{ hrs. } 8 \text{ mins.} + 11 \text{ mins.} = 5 \text{ hrs.} - 19 \text{ mins. P.M.}$$

The same Calculations for lat. of place = 35°½ N.

		A	B	C
Long. of cul. pt.	=	107° 46′ 25″	136° 50′ 5″	168° 32′ 16″
θ′	=	82° 13′ 23″	71° 55′ 36″	66° 19′ 28″
Dec. of cul. pt.	=	+22° 53′ 11″	+16° 13′ 25″	+4° 39′ 18″
Lat. of place	=	+35° 30′ 0″	+35° 30′ 0″	+35° 30′ 0″
Z. dist. of cul. pt. = ZC	=	12° 36′ 49″	19° 16′ 35″	30° 50′ 42″
Z. dist. of nonagesimal = ZN	=	12° 29′ 44″	18° 17′ 25″	28° 0′ 20″
Parall. in lat.	=	− 13′ 16″·1	− 19′ 14″·7	− 28′ 17″·7
Moon's lat.	=	+ 40′ 45″·5	+ 33′ 47″·0	+ 26′ 46″·9
Corrected lat.	=	+ 27′ 29″·4	+ 14′ 32″·3	− 2′ 0″·8
Z. dist. of cul. pt. = ZC	=	12° 36′ 49″	19° 16′ 35″	30° 50′ 42″
θ′	=	82° 13′ 23″	71° 55′ 36″	66° 19′ 23″
Cul. pt. − nonagesimal = CN	=	1° 44′ 4″	6° 11′ 32″	13° 20′ 9″
Cul. pt.	=	107° 46′ 25″	136° 50′ 5″	168° 32′ 16″
Nonagesimal	=	106° 2′ 21″	130° 38′ 33″	155° 12′ 7″
App. Sun	=	90° 12′ 1″	90° 16′ 55″	90° 21′ 51″
Nonagesinal − Sun	=	15° 50′ 20″	40° 21′ 38″	64° 50′ 16″
Z. dist. of nonagesimal = ZN	=	12° 29′ 44″	18° 17′ 25″	28° 0′ 20″

Horizontal parallax of (Moon − Sun) = 3670″·6

Parallax in long	=	− 16′ 18″·1	− 37′ 36″·9	− 48′ 53″·1
Long. of Moon	=	89° 6′ 53·5	90° 22′ 40″·9	91° 38′ 29″·8
Corrected Long	=	88° 50′ 35″·4	8° 45′ 4″·0	90° 49′ 36″·7
Sun	=	90° 12′ 1″	90° 16′ 55″	90° 21 51
☽ − ☉	=	−1° 21′ 26″	−0° 31′ 51″	+0° 27′ 46″
	=	−4886″	−1911″	+1666″
1st diff.	=	+2975″	+3577″	
2nd diff.	=		+602″	

∴ ☽ − ☉ = χ = $-1911'' + 3277t + 301t^2$ whrere t is measured in units of 2 hrs. from B.

Corrected lat.	=	+ 27′ 29″	+ 14′ 32″	− 2′ 1″
	=	+ 1649″	+872″	−121″
1st diff.	=	−777	−993	
2nd diff.	=		−216	

Corrected lat. = ψ = $+872'' - 885\ t - 108t^3$

Sum of Semi-diameters = 1964″(M + S)

Diff. ,, ,, ,, = 41″(M − S)

Kurukṣetra mean time.	χ	ψ	$\sqrt{\chi^2+\psi^2}$		
3-8 P.M.	−1911″	+872″	2101″	−422	
3-23 ,,	−1497	+760	1679	−428	
3-38 ,,	−1073	+644	1251	−423	
3-53 ,,	−640	+525	828	−379	
4-8 ,,	−198	+403	449	−73	+306
4-23 ,,	+254	+277	376	+354	+427
4-38 ,,	+715	+148	730	+456	
4-53 ,,	+1186	+15	1186	+484	
5-8 ,,	+1666	−121	1670	+502	
5-23 ,,	+2156	−260	2172		

Time of beginning= $=\frac{2101-1964}{422}\times 15$ mins. $=4{\cdot}87$ mins.

after 3-8 P.M, *i,e.*, at 3-13 P.M.

Time of ending= $\frac{1964-1670}{502}\times 15$ mins. $=8{\cdot}79$ mins

after 5-8 P.M., *i.e.*, at 5-17 P.M.

Duration of eclipse = 2 hrs. 4 mins.

Nearest approach of the centres = 361″ at 4-18 P.M.

Mag of eclipse = 0·792 = 9·5 Indian units.

APPENDIX III

A Note on a Method

of

Finding a Central Solar eclipse near a Past Date

The problem of the chapter to which this is an appendix, was to find a central solar eclipse on the summer solstice day, visible in the northern Punjab, within the range 4000 B.C. to 2400 B.C. As shown in the body of the paper a central solar eclipse happening on the 21st. July, 3146 B.C., obtained by a pure chance formed the starting point for further calculations. A method now occurs to me which shows that a chronologist need not depend upon any such chance. Further he need not also depend on a book like Oppolzer's in which all eclipses are calculated from 1200 B.C. up to the modern times. The equations for the moon's elements used by Oppolzer were those given by Hansen, which have been thrown away by international astronomers. Hence Oppolzer's great work has become more or less valueless. We have now to use Newcomb's equations for the sun's elements and Brown's for those of the moon. To undertake another great work like that of Oppolzer with the most up to date system of astronomical constants should be now considered unnecessary on the score of the labour it entails, in the light of the elegant method presented in this note.

Problem 1. To find a central solar eclipse near the date 4000 B.C. happening on the summer solstice day and visible from the northern Punjab.

Here we are to remember that the longitude of the ascending node should be about 85° or that of the descending node about 95°, on the day of the eclipse if this is to be visible from the northern Punjab.

(*a*) We first work out the shifting of the equinoxes from 4001 B.C. to the present time, say 1940 A.D. This works out to have been 82° 27′ 23″ nearly. Hence what was 90° of the longitude of the sun in 4001 B.C., would become 172° 27′ 23″ in 1940. The sun has this longitude now about the 16th September.

(*b*) Now on looking up the nautical almanacs, we find that there was a new-moon on the 15th September, 1936.

(*c*) Again from 4001 B.C. to 1940 A.D., the number of years elapsed = 5940. The correct luni-solar cycles in sidereal years are 1939 and 160 years

$$\text{Now } 5940 = 1939 \times 3 + 123.$$

Hence the elapsed years 5940, have to be increased by 37 years and we have,

$$5977 = 1939 \times 3 + 160.$$

(*d*) We then apply 5977 sidereal years or 2183137 days backward to the date, 15th September, 1936, and arrive at the date 4042 B.C., July, 26.

(*e*) On this date G.M.N., the longitude of the moon's ascending node was = 321° 42′ 36°·82.

(*f*) We now use the eclipse cycle of 19 tropical years in which the node's position is decreased by 7° 32′ nearly. We want to reduce the longitude of 321°43′ of the node to about 275°, *i.e.*, by 46° 43′ which comprises 7°32′ six times nearly. Hence we have to come down 19 × 6 or 114 years. The year arrived at is 3928 B.C. Calculation of the eclipse on the summer solstice day of this year may now proceed as shown in the body of the paper, remembering that in 114 years (tropical) there are 41638 days.

Problem 2. To find the central solar eclipse which happened on the autumnal equinox day visible in the northern Punjab and near about the year 1400 B.C.

On the autumnal equinox day the sun attains the longitude of 180°. In order that the eclipse may be visible in the northern Punjab, the ascending node should have a longitude of about 175° or the descending node 185° nearly.

(*a*) From 1401 B.C. till 1940 A.D. the shifting of the equinoxes becomes 46° 17′ 26″. Hence what was 180° of the longitude of the sun in 1401 B.C. has become 226° 17′ 26″ in present times. This corresponds to the date of November, 10 of our times.

(*b*) On looking up nautical almanacs we can find that a new-moon happened on November, 10, 1931 A.D.

(*c*) Now the elapsed years 3340, till 1940 A.D. need be adjusted a little as before; we have to increase it by 39 years, and we have,

$$3379 = 1939 + 160 \times 9.$$

(*d*) We apply to the 10th November, 1931 A.D., 3379 sidereal years or 1234201 days backward, and arrive at the date 1449 B.C. October, 5.

(*e*) On this date the longitude of the ascending node at G.M.N. was = 201° 2′ 23″.

(*f*) We have to reduce this longitude of the node to 175° nearly by using our eclipse cycles. Now by our cycle of 19 years, repeated four times, we can reduce it by 30° 8′ to 170° 54′ by coming down to 1373 B.C. We have now to raise it from 170° 54′ by a further coming down by the eclipse cycle of 372 years, to 175° 15′ nearly for the autumnal equinox day of the year *1001 B.C., as in Oppolzer's finding*.

Altogether we had to come down by $19 \times 4 + 372 = 448$ tropical years.

Hence by the method thus illustrated, we can find near about any past date, any sort of solar eclipse we have any record of, however vague it may be. There is thus no necessity for finding all the solar eclipses from so far back a date as 4000 B.C. up to our modern times.

I trust the attention of astronomers and chronologists all over the world, will be drawn to the method presented here for finding an eclipse of a back date, and hope they would further develop it and remove from it any flaws that they may discover.

CHAPTER X

VEDIC ANTIQUITY

Heliacal Rising of λ and ν Scorpionis in Atharva Veda

In the Atharva Veda[1] the heliacal rising of the two stars λ and ν *Scorpionis* is mentioned in II, 8 and III, 7. We quote the first verse as translated and annotated by Whitney. It is almost the same verse that is repeated in the two hymns which were used in incantations for relief from the disease *Kṣetriya.*[1]

" Arisen are the two blessed stars called unfasteners (*Vicṛta*) ; let them unfasten (*Vimuc*) of the *Kṣetriya* the lowest, the highest fetter."

Whitney's note runs as follows :—

' The disease *Kṣetriya* (lit'ly, of the field) is treated elsewhere, especially in iii, 7 (mentioned also in ii. 10 ; 14·5 ; iv. 18·7). The commentator defines it here as apparently an infectious disorder, of various forms, appearing in a whole family or perhaps endemic. The name *Vicṛtau*, 'the two unfastners' is given later to the two stars in the sting of the Scorpion (λ and ν *Scorpionis*), and there seems to be no good reasons to doubt that they are the ones here intended ; the selection of two so inconspicuous stars is not any more strange than the appeal to stars at all ; the commentator identifies them with *Mūlā*, which is the asterism composed of the scorpion's tail."

Whitney concludes by " Their (the two stars) healing virtue would doubtless be connected with the meteorological conditions of the time at which their heliacal rising takes place ".[2]

[1] (*a*) उदगातां भगवती विचृतौ नाम तारके ।
विक्षेत्रियस्य मुञ्चतामधमं पाशमुत्तमम् ॥१॥
A. V. II, 8, 1.

(*b*) अमूर्ये दिवि सुभगे विचृतौ नाम तारके ।
विक्षेत्रियस्य मुञ्चतामधमं पाशमुत्तमम् ॥४॥
A. V. III, 7, 4.

According to Sāyaṇa, *kṣetriya* diseases are Phthisis, Leprosy, Epilepsy, Hysteria and the like. We feel that the diseases included under this name *Kṣetriya* are those skin and lung diseases which are aggravated by rainy weather and are relieved by the dry atmospheric conditions which follow the rainy season. The sore toes which the cultivators have in the rainy season are perhaps also included under the name *Kṣetriya*. The season-beginning indicated by the heliacal rising of λ and ν *Scorpionis* was that of *Hemanta* or the dewy season.

In Indian astronomy, there are recognised six seasons in the twelve months of the year, commencing from the winter solstice day and they are named winter, spring, summer, rains, autumn and *Hemanta* or the dewy season. The seasons, rains and autumn comprise four months which are called *Vārṣika* in Sanskrit literature, during which the gods are supposed to sleep. These four months are called *Vārṣika* (rainy) months in the *Rāmāyaṇa*. Thus the sun's celestial longitude at the end of these four months becomes 210°, when the sky is finally 'released' from the clouds according to the estimate of the Sanskrit authors.

That the true heliacal rising of the stars λ and ν *Scorpionis* is meant is seen from the following verses with Whitney's commentary.

"Let this night fade away (*apa-vas*) ; let the bewitchers fade away ; let the *Kṣetriya*-effacing (*-nāśana*) plant fade the *Kṣetriya* away."[1]

"In the fading out of the asterisms, in the fading out of the dawns also, from us fade out all that is of evil nature, fade out the *Kṣetriya*."[2]

[2] Burgess' *Sūryasiddhānta*, VIII, 9, notes on the *Mūlā* 'junction star.'

[1] अपेयं रात्र्युच्छत्वपोच्छन्त्वभिकृत्वरीः ।
वीरुत्क्षेत्रियनाशन्यप क्षेत्रियमुच्छतु ॥
A. V. II, 8. 2.

[2] अपवासे नक्षत्राणामपवास उषसामुत ।
अपास्मत् सर्वं दुर्भूतमप क्षेत्रियमुच्छतु ॥
A. V. III, 7, 7.

Whitney's note :—

"The night at the time of dawn is meant, says the Commentator (doubtless correctly).........According to Kauś the hymn accompanies a dousing with prepared water outside the house ; with this verse it is to be done at the end of the night."

Thus there is no doubt that the true heliacal rising of the stars λ and ν *Scorpionis* is meant. Although the two stars are inconspicuous according to Whitney, the position of the two stars at the end of the tail of *Scorpionis* is remarkable to any watcher of the heavens, as they are very close together, marking the end of the tail. The astronomical data is now that there was a time in the Vedic *(Atharvaṇ)* Hindu culture when the heliacal rising of λ *Scorpionis* marked the coming of *Hemanta* or the Dew-season with the sun having the celestial longitude of 210°. We take Kurukṣetra, as before, for the place of observation, which has a latitude of 30°N.

For 1934, the star λ *Scorpionis* had its—

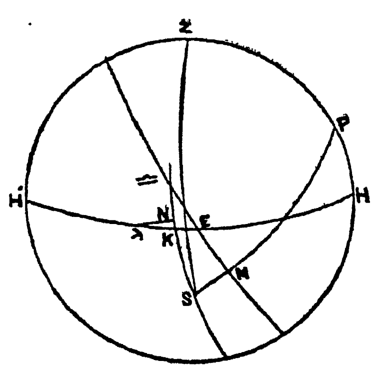
Mean right ascension = 17 hrs. 29 mins. 7·437 secs., and the mean declination = −37° 3′ 26″·59 secs., while the obliquity of the ecliptic,

ϖ = 23° 26′ 52″·33.

Hence for 1934, the celestial longitude of the star = 263° 39′ 50″ and the celestial latitude = −13° 46′ 46″.

The obliquity of the ecliptic for 3400 B.C., our assumed date, was = 24° 3′ 42″.

Now when the sun's longitude was 210° the right ascension was = 207° 47′ 51″, and the declination was = −11° 45′ 46″.



Let the above figure represent the celestial sphere of the observer at Kurukṣetra, HPZH′ the meridian, H′λKEH the horizon; S the position of the sun at 18° below the horizon, P the celestial pole and Z the zenith. λ is the point of the east horizon where the star λ *Scorpionis* rose. Here ♎NKS is the ecliptic. Join ZS and PS by arcs of great circles, PS cutting the celestial equator at the point M. From λ draw λN perpendicular to the ecliptic. We want to determine ♎N.

Now ZP = 60°, ZS = 108°, PS = 90° + δ = 101° 45′ 46″, ♎S = 30°, ♎M = 27° 47′ 51″, ∠ KE♎ = colatitude = 60° and λN = 13° 46′ 46″.

(1) In the triangle ZPS, the three sides ZP, ZS and PS are known. Hence the angle ZPS comes out to be = 104° 8′ 16″

and the ∠ZPE is 90° degrees

∴ the arc EM = 14° 8′ 16″

Now ♎M as found already = 27° 47′ 51″

∴ ♎E = 13° 39′ 45″.

(2) In the triangle E♎K, the four consecutive parts are :—

∠ KE♎ = 60°, E♎ = 13° 39′ 45″, ∠ E♎K = 24° 3′ 42″

and ♎K.

Hence we find ♎K = 11° 52′ 44″ and the

angle K = 83° 29′ 23″.

(3) Now from the triangle λNK, we find

that KN = 1° 36′ 13″.

Finally ♎K = 11° 52′ 44″

NK = 1° 36′ 13″,

∴ ♎N = 10° 16′ 31″.

Hence celestial longitude of λ *Scorpionis* at the required past date was = 190° 16′ 31″. Now in 1934, the same was = 263° 39′ 50″ or the increase in the celestial longitude of the star λ *Scorpionis* = 73° 23′ 19″.

The mean precession rate = 49″·6761.

Hence the number of years elapsed till 1934 A. D. = 5318, ignoring the proper motion of the star. Thus the date becomes 3385 B.C.

We have here worked out the date for a tradition about the beginning of autumn at the latitude of Kurukṣetra: but we cannot say that this was the date of the entire *Atharva Veda* Further we are not sure if the observer's place was 30°N latitude. If we suppose that the observation was made at about 25°N, the date arrived at would not lower it by more than a hundred years. Hence the *Atharva Veda* in some of its portions was begun about 3400 B.C. Although this Veda is traditionally later than the *Ṛg-Veda,* some portions of it are undoubtedly earlier than the tenth *Mandala* of the *Ṛg veda* and must be dated at about 2449 B.C., the date of the Bhārata battle.

CHAPTER XI

VEDIC ANTIQUITY

Yama and his Two Dogs

The Vedic god Yama was the Lord of the *Pitṛs* (the departed Fathers) and son of *Vivasvant* (Sun). In the Avestic literature he is *Yima,* the son of *Vivanghat* (*Vendiad,* Fargard II, 1, 2 etc.). The *Pitṛs* or manes were or are the souls of the departed and according to a Hindu's daily ceremony of libation offering to his forefathers are classed into *Agniṣvāttas, Saumyas, Haviṣmanta, Uṣmapās, Saukālins, Barhiṣads* and the *Ājyapas.* In the *Ṛg-veda,* however, we get the names of the Fathers as *Barhiṣads, Saumyas* and the *Agniṣvāttas* only. According to Wilson in Manu they are also termed *Agniṣvāttas, Barhiṣads* and the *Saumyas.* These *Pitṛs* are invoked by the libation offerers as protectors. If the order of the *Pitṛs* be the lower, the upper and the intermediate, their names are perhaps *Barhiṣads, Saumyas* and *Agniṣvāttas* (*Ṛg-Veda*) in the same order. Now-a-days the *orders* of the *Pitṛs* has been increased into seven, the addition being the orders *Haviṣmantas, Usmapās, Ājyapas* and the *Saukālins.* It does not interest us for the present to enquire when these additions were made in the Hindu faith. We are here concerned with the faith about their place of abode and of their Lord Yama. On this point the *Śatapatha Brāhmana* says:—

" 'Two worlds in truth there are,' they say, the 'world of the gods' and the 'world of the Fathers' (*Pitṛs*)." [1]

" The world of the gods is in the north and the world of the Fathers (*Pitṛs*) in the south." [2]

[1] द्वौ वाव लोकावित्याहुर्देवलोकश्च पितृलोकश्च ।

—*Ś. Brāhmaṇa,* XII, 7, 3, 7.

[2] उत्तरो वै देवलोको दक्षिणः पितृलोकः ।

—*Ibid.*

Thus the *Pitṛs* live in the south, consequently their Lord Yama must also be a dweller of the south. In a modern Sanskrit Dictionary, Yama is defined to be 'a god appointed by the Supreme Lord for deciding the destinies of departed souls according to their good or bad deeds in this world of ours, and is stationed in the south.' In the *Mahābhārata, Vanaparva,* in the story of Sāvitri, it is said that 'Yama having bound the soul of Satyavān went southward.' In another Sanskrit Dictionary Yama is defined as 'the lord of the southern direction.' Hence according to the Hindu faith both Yama and his subjects, the *Pitṛs*, are dwellers of the south. The Sanskrit word '*Yāmya*' meaning the south, is derived from Yama, the lord of the south.

The Hindu when offering libations to his fathers, has to turn to the south and invoke them by the following verse :

" Our fathers, the *Saumyas* and the *Agniṣvāttas* come by the *Devayāna* route (northward direction) be delighted at the sacrifice by enjoying our offering *(Svadhā)* and bless us. May they protect us."[1]

There are the two routes spoken of in the Hindu sacred lore, the one is the *Devayāna* and the other the *Pitṛyāna*, respectively the route of the gods and the route of the Fathers. When the Fathers come, they come by the *Devayāna* route and when they go back, they certainly follow the *Pitṛyāna* route. Thus both the routes may lie on the same meridian, the former is the northward direction and the latter the southward direction. Here we have to differ from Tilak who in the book *Orion* would interpret that *Devayāna* route is the part of the ecliptic lying north of the celestial equator and the *Pitṛyāna* route, the part of the ecliptic south of the celestial equator. His interpretation appears to be unjustifiable and incorrect, as the Fathers who come from the south do follow according to the Hindu faith the *Devayāna* route.

When men die they follow according to Hindu faith the *Pitṛyāna* route or the southern direction. In this route to the abode of Yama, lay two dogs which were both "spotted four-eyed

[1] आयान्तु नः पितरः सौम्यासोऽग्निष्वात्ताः पथिभिर्देवयानैः । अस्मिन् यज्ञे स्वधया मदन्तोऽधि-ब्रुवन्तु ते अवन्त्वस्मान् ।

dogs." The *Ṛg-veda* verses addressed to the souls of men just departed run thus [1] :—

"Pass by a secure path beyond the two spotted four-eyed dogs, the progeny of Saramā, and join the wise *Pitṛs* who rejoice fully with Yama."

"Entrust him, O king, to thy two dogs, which are thy protectors, Yama, the four-eyed guardians of the road, renowned by men, and grant him prosperity and health,"—(Wilson)

In the *Atharva Veda* also the corresponding verses are [2] :—

"Run thou past the two four-eyed, brindled dogs of Saramā, by a happy road; then go to the beneficent Fathers, who revel in common revelry with Yama."

"What two defending dogs thou has, O Yama, four eyed, sitting by the road, men watching, with them, O King, do thou surround him; assign to him well-being and freedom from disease."—(Whitney)

These two dogs we take to have been the two stars α *Canis minoris* and α *Canis majoris*. The astronomical interpretation becomes that there was a time, Vedic or pre-Vedic, when these two stars pointed to the south celestial pole, *i.e.*, at that time these two stars crossed the meridian simultaneously or they had the same right ascension. We now investigate this problem of determining this past time astronmically.

The places of these stars for 1931 A.D are given as follows in the Nautical Almanac.

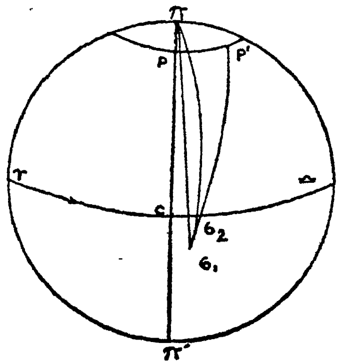
Star	Right Assension	Declination
α *Canis Majoris*	$6^h\ 42^m\ 6^s{\cdot}524$	$-16°\ 37'\ 13''$
α *Canis Minoris*	7 35 41·405	$5°\ 24'\ 11''$

[1] अतिद्रव सारमेयौ श्वानौ चतुरक्षौ शबलौ साधुना पथा। अधा पितॄन्त्सुविदत्राँ उपेहि यमेन ये सधमादं मदन्ति ॥१०॥ यौ ते श्वानौ यम रक्षितारौ चतुरक्षौ पथिरक्षी नृचक्षसौ। ताभ्यामेनं परिदेहि राजन् स्वस्ति चास्मा अनमीवं च धेहि ॥११॥ —*Ṛg-Veda*, X, 14, 10-11.

[2] अतिद्रव श्वानौ सारमेयौ चतुरक्षौ शबलौ साधुना पथा। अधा पितॄन्त्सुविदत्राँ अपीहि यमेन ये सधमादं मदन्ति ॥११॥ यौ ते श्वानौ यम रक्षितारौ चतुरक्षौ पथिषदी नृचक्षसा। ताभ्यां राजन् परिधेह्येनं स्वस्त्यस्मा अनमीवं च धेहि ॥१२॥ —*Atharva Veda*, XVIII, 2, 11-12

The mean obliquity of the ecliptic was 23° 26′ 54″ in 1931 A.D. Hence by transformation of co-ordinates, we get:—

Star	Celestial longitude	Celestial latitude
α Canis Majoris	103° 7′ 52″	−39° 35′ 24″
α Canis Minoris	114° 50′ 0″	−16° 0′ 24″



In the above figure of the celestial sphere, let γC♎ be the ecliptic, π the pole of the ecliptic, P the celestial pole and C the summer solstice in 1931 A.D. Let σ_1 and σ_2 be the positions of *α Canis Majoris* and *α Canis Minoris* in 1931. Let σ_1 and σ_2 be joined by an arc of a great circle cutting the path of the celestial pole in P′. Then P′ was the pole of the equator at the required time. The angle $P'\pi P$ represents the shifting of the solstices.

(1) In the triangle $\pi\sigma_1\sigma_2$ the four consecutive parts are :—

$\angle\sigma_2\sigma_1\pi$, $\sigma_1\pi = 90° + 39°35'24''$, $\angle\sigma_1\pi\sigma_2 = 11°42'8''$,
$\pi\sigma_2 = 90° + 16°0'24''$

∴ we get,

$$\cot \sigma_2\sigma_1\pi \times \sin 11°42'8''$$
$$= \cos 11°\ 42'\ 8'' \times \sin 39°\ 35'\ 24'' - \tan 16°\ 0'\ 24''$$
$$\times \cos 39°\ 35'\ 24''.$$

Now put $\cot \phi = \dfrac{\cos 11^\circ\ 42'\ 8''}{\tan 16^\circ\ 0'\ 24''}$ $\therefore$ $\phi = 16^\circ\ 19'\ 43''$.

Hence we get,

$$\cot \sigma_2\sigma_1\pi = \frac{\tan 16^\circ\ 0'\ 24'' \times \sin 23^\circ\ 15'\ 41''}{\sin 11^\circ\ 42'\ 8'' \times \sin 16^\circ\ 19'\ 43''}$$

$$\therefore \quad \sigma_2\sigma_1\pi = 26^\circ\ 42'\ 55''.$$

(2) Again in the triangle $\sigma_1\pi P'$, the value of $\pi P'$ was very nearly $24^\circ\ 7'\ 32''$ about 4350 B.C. The four consecutive parts are:—

$$\angle\ P'\sigma_1\pi = 26^\circ\ 42'\ 55'', \quad \pi\sigma_1 = 90^\circ + 39^\circ\ 35'\ 24'',$$
$$\angle\ \sigma_1\pi P', \ \pi P = 24^\circ\ 7'\ 32''.$$

We get readily,

$$\sin \sigma_1\pi P' \times \cot 26^\circ\ 42'\ 55'' - \cos \sigma_1\pi P' \times \sin 39^\circ\ 35'\ 24''$$
$$= \cot 24^\circ\ 8'\ 42'' \times \cos 39^\circ\ 32'\ 24''.$$

Put $\cot\ \theta = \dfrac{\cot 26^\circ\ 42'\ 55''}{\sin 39^\circ\ 36'\ 24''}$

then $\theta = 17^\circ\ 47'\ 0''$.

Hence we get,

$$\sin (\sigma_1\pi P' - \theta) = \sin \theta \times \cot 24^\circ\ 7'\ 32'' \times \cot 39^\circ\ 35'\ 24''$$

$$\therefore \quad \sigma_1\pi P' = 17^\circ\ 47'\ 0'' + 55^\circ\ 33'\ 5'' = 73^\circ\ 20'\ 5''$$

The celestial longitude of α *Canis Majoris* (1931 A.D.)
$= 103^\circ\ 7'\ 52''$

Hence the celestial longitude of P' for 1931 A.D.
$= 103^\circ\ 7'\ 52'' + 73^\circ\ 20'\ 5'' = 176^\circ\ 27'\ 57''$.

$\therefore$ the $\angle\ P\pi P'$ or the shifting of the summer solstitial point up to 1931 A.D. $= 176^\circ\ 27'\ 57'' - 90^\circ = 86^\circ\ 27'\ 57''$.

The elapsed time thus comes out to be 6280 years till 1931 A.D. and the required date is, therefore, 4350 B.C.

Second Method.

We can follow a second method to determine the past time when α *Canis Majoris* and α *Canis Minoris* had the same right

ascension. In Dr. Neugebauer's *Sterntafeln*, the right ascensions and declinations of stars are given at intervals of 100 years, extending from 4000 B.C. downwards. We tabulate the right ascenisons of these two stars from −3600 to −4000 A.D.

Year	R. A. of *a Canis Majoris*	R. A. of *a Canis Minoris*	Difference	2nd. diff.
−3600	40°·12	41°·66	1°·54	
				·17
−3700	39·04	40·41	1·37	
				·16
−3800	37·96	39·17	1·21	
				·16
−3900	36·88	37·93	1·05	
				·16
−4000	35·80	36·69	0·89	

From a comparison of the second differences we find that these become steady from −3700 A.D. at the rate of 0°·16 per hundred years. Hence the difference between the right ascensions of the two stars would vanish $\frac{\cdot 89}{\cdot 16} \times 100$ years or 556 years before −4000. A.D. *i.e.* at about 4557 B.C.

There is thus a difference of about 200 years in the two determinations of the time of the event by the two methods; but I trust the date obtained before *viz.* 4350 B.C. is the more correct, as it is based on the elements of these stars determined by using more accurate instruments in recent times. Another point that needs be considered here is this: What must have been the initial error of observation in this connection.

Now let us see what could have been the initial error if the epoch for the observation be taken as 4000 B.C.

The total shifting of the equinoxes during the interval of 5930 years between 4000 B.C. to 1931 A.D. = 81°42′50″. If this be subtracted from the celestial longitudes of the stars for 1931 A.D., we get their position in 4000 B.C. Hence the

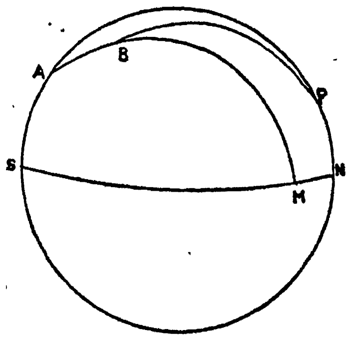
celestial co-ordinates of the stars in 4000 B.C. are as follows (supposing the latitude to remain the same throughout) :—

Star	Celestial longitude	Celestial latitude
a Canis Majoris	21° 24′ 59″	−39° 35′ 24″
a Canis Minoris	33° 7′ 7″	−16° 0′ 24″

In 4000 B.C. the obliquity of the ecliptic was $\varpi = 24°6'35''$.

Hence by transformation of the co-ordinates, we get :—

Star	Right Ascension	Declination
a Canis Majoris	35° 46′ 27″	−27° 50′ 28″
a Canis Minoris	36° 19′ 42″	−2° 8′ 48″



In the above figure let A represent the position of the star *Canis Majoris* when on the meridian at the latitude of Kurukṣetra (30° N) in 4000 B.C. and B the position of the other star *a Canis Minoris*, NMS the eastern horizon. Join AB by an arc of a great circle and produce it to meet the horizon at M. Join B to P, the pole of the celestial equator.

Now in the triangle ABP, the four consecutive parts are:

$\angle$BAP, AP = 90°+27° 50′ 28″, $\angle$ APB = 0° 35′ 15″
and PB = 90°+2° 8′ 48″.

By solution of the triangle, the $\angle$ BAP is found to be 1° 16′ 37″

Now in the triangle ANM, we have

AN = AP+30° = 147° 50′ 28″
$\angle$ MAN = 1° 16′ 37″ and $\angle$ MNA = a rt. angle.

Now tan MN = sin AN. tan MAN.

Therefore MN is found to be 0° 40′ 47″.

There was thus not much azimuth error even at 4000 B.C. at Kurukṣetra, if the observer took the great circle passing through the two stars as lying on the meridian, at the time of the transit of α *Canis Majoris.*

The mean date for the equality of the right ascensions of these stars being 4350 B.C., as shown before, we have thus shown that the date may as well be brought down to 4000 B.C. Equally strong reasons there may also be for raising the date by 350 years, *viz.*, to 4700 B.C. Further the mythology as to Yama and his two dogs was perhaps the same for the Hindus, the Greeks and the Parsis.

The *Ṛg-Veda* also speaks of the divine Vessel or boat in the following terms[1] :—

" May we for our well-being ascend the well-oared, defectless, unyielding divine vessel, the safe-sheltering expansive heaven, exempt from evil, replete with happiness, exalted and right directing."—(Wilson)

The *Atharva Veda* also says :—

" A golden ship, of golden tackle, moved about in the sky ; there the gods won the *Kuṣṭha*, the flower of immortality." [2]

—(Whitney) *A.V.* V, 4, 4 and VI, 95.2

[1] सुत्रामाणं पृथिवीं द्यामनेहसं सुशर्माणमदितिं सुप्रणीतिम् ।
दैवीं नावं स्वरित्रामनागसमस्रवन्तीमारुहेमा स्वस्तये ॥१०॥

—*Ṛg-Veda*, X, 63, 10.

[2] हिरण्ययी नौरचरद्धिरण्यबन्धना दिवि ।
तत्रामृतस्य पुष्पं देवाः कुष्ठमवन्वत ॥४॥

"The well-oared ship of the gods, unleaking, may we, guiltless, embark in order to well-being." [1]

"A golden ship of golden tackle, moved about in the sky: there is the sight of immortality ; thence was born the *Kuṣṭha*." [2]

—(Whitney)

Here the wish is, perhaps, that the departed souls going southward by the road guarded by the two dogs, α *Canis Minoris* and α *Canis Majoris*, may ascend the divine boat—*Argo-Navis* and enjoy blissful expeditions in the heavenly river—the milky way in the world of Yama.

All these constellations *viz.*, the two dogs and the *Argo-Navis* are to be found not only in the Vedas, but also in Greek and the Parsi Mythology. While in the Hindu literature these constellations were forgotten and called by other names, for example *Canis Majoris* by *Lubdhaka* (the Hunter) and *Canis Minoris* by a star of the nakṣatra *Punarvasu* and the *Argonavis* is quite lost sight of in the later Hindu literature, the constellations are still used and so named in western astronomy. The names of the two dogs of Yama are preserved in the *Zendavesta.*[3] In the Parsi legend these two dogs 'keep the *Kinvat* Bridge' as imagined to have been made over the milky way. In the Greek legend the milky way is crossed by a ferry boat, *i.e.*, the *Argonavis*.

All these considerations lead us to think that the tradition about Yama's Dogs, belongs to the date of about 4700 B.C. and before the time when the Āryan peoples migrated to different

हिरण्मया: पन्थान: आसन्नरित्राणि हिरण्मया ।
नावो हिरण्ययीरासन् याभि: कुष्ठं निरावहन् ॥५॥

[1] सुत्रामाणं पृथिवीं द्यामनेहसं सुशर्माणमदितिं सुप्रणीतिं ।
दैवीं नावं स्वरित्रामनागसो अस्रवन्तीमारुहेमा स्वस्तये ॥

—*A. V.* VII, 6, 3.

[2] हिरण्ययी नौरचरद्धिरण्यबन्धना दिवि ।
तत्रामृतस्य चक्षणं तत: कुष्ठो अजायत ॥

—*A. V.* 19, 39. 7.

[3] Sacred Books of the East—*The Zend-Avesta*, Vol. IV : pages 190, F. XVIII, 6 (14), page 213, F. XIX, 30 (98) ; also page 150, F. XIII. 9 (24). See also Introduction to the same, p. lxxxvii § 4.

countries from their ancient homes. This ancient tradition in relation to the above constellations survived in the Vedas and with the western immigrants. These Aryan peoples probably lived near about the Central Asian mountain range running east west from the Mediterranean Sea to the Pacific Ocean. Here I have to differ from late Tilak, who in his book '*Orion*', in the chapter on "the antelope's head," cites this tradition as a confirmation of his finding that the vernal equinox for the time was at the Antelope's Head' which according to him was the *Mṛgaśira's* cluster. The tradition belongs to the pre-Vedic age, as I have shown before.

CHAPTER XII

VEDIC ANTIQUITY

Legend of Prajāpati and Rohiṇi

In the *Aitareya Brāhmaṇa*[1] (iii, 36 or ch. 13, 9) the above legend is thus stated. We quote below the translation by Keith in his *Ṛg-Veda Brāhmaṇas*:

" Prajāpati felt love for his own daughter, the sky some say, *Uṣās* others. Having become a stag he approached her in the form of a deer (who had also become a deer). The gods saw him. 'A deed unknown Prajāpati now does.' They sought one to punish him; they found him not among one another. The most dread forms they brought together in one place. Brought together they became this deity here; therefore is his name containing (the word) *Bhūta*; he prospers who knows thus his name. To him the gods said, 'Prajāpati here hath done a deed unknown; pierce him.' 'Be it so' he replied, 'Let me choose a boon from you.' 'Choose' (they said). He chose this boon, the over-lord-ship of cattle; therefore does his name contain the word 'cattle.' Rich in cattle he becomes who knows thus this name of his. Having aimed at him, he pierced him; being pierced he flew up upwards; him they call 'the deer.' The piercer of the deer is he of that name (*Mṛgavyādha*). The

[1] प्रजापतिर्वै स्वां दुहितरमभ्यध्यायद्दिवमित्यन्य आहुरुषसमित्यन्ये तामृश्योभूत्वा रोहितं भूता-मभ्यैत् तं देवा अपश्यन्नकृतं वै प्रजापतिः करोतीति ते तमैच्छन्य एनं मारिष्यत्येतमन्योन्यस्मिन्नाविदं-स्तेषां या एव घोरतमास्तन्व आसंस्ता एकधा समभरंस्ताः संभृता एष देवो भवत्तदस्यै तद्भूतवन्नाम भवति वै स योऽस्यैतदेवन्नाम वेद तं देवा अब्रुवन्नयं वै प्रजापतिरकृतमकरिमं विध्येति स तथेत्यब्रवीत् स वै वो वरं वृणा इति वृणीष्वेति स एतमेव वरमवृणीत पशूनामाधिपत्यं तदस्यैतत् पशुमन्नाम पशुमान् भवति योऽस्यैतदेवं नामवेद तमभ्यायत्या विध्यत् स विद्ध ऊर्ध्वउदप्रपत तमेतं मृग इत्याचक्षते य उ एव मृगव्याधः स उ एव स या रोहित् सा रोहिणी यो एवेषु स्त्रिकाण्डासो एवेषु स्त्रिकाण्डा तद्वा इदं प्रजापतेरेतस्सिक्तमधावत्तत्सरो भवत् ॥

female deer is Rohiṇī. The three pointed arrow is the three pointed arrow (*trikāṇḍā*). The seed of Prajāpati outpoured ran; it became a pond (*Saras* = a lake ?)."

The Aitareya Brāhmaṇa passage is concluded by the sentence "for the gods are lovers of mystery as it were." We would add here that not only were the gods lovers of mystery but that their worshippers, the Vedic people were more so. If again Prajāpati were a real person, we can only imagine how he would have treated those people who were his worshippers and who indulged in such an obscene and vulgar allegory about himself.

This legend has been noticed by Tilak in his *Orion*, S. B. Dikṣita in his *Bhāratīya Jyotiḥśāstra*, but the correct astronomical interpretation has not yet been found. Tilak and Dikṣita would understand that the astronomical phenomenon referred to in the passage indicates the time when the vernal equinox was at the *Mṛgaśiā* cluster or λ, ϕ_1 and ϕ_2 *Orionis*. But our interpretation would be different. For the legend we have also to compare *S. Br.* I, 7, 4, 1; *Rv.* X, 61, 5-9," as Keith states. Another reference is *Tāṇḍya Br.* 8, 2, 10. The *Mahābhārata Sauptika parva*, 18, 13-14, is another place where the same legend is stated without any obscenity as found in the *Ṛg-Veda* and the *Aitareya Brāhmaṇa*. It is possible, however, that the *M. Bh.* legend is later than the one recorded in the Vedic literature. The Vedic legend speaks of the birth of Rudra, while the *M. Bh* legend refers to the ignoring by the gods of the share of Rudra in a sacrifice.

The phenomenon of Prajāpati meeting his daughter Rohiṇī is stated in the *Ṛg-Veda* as to have happened in mid-heaven thus.[1]

" When the deed was done in *mid-heaven* in the proximity of the father working his will, and the daughter coming together, they let the seed fall slightly; it was found upon the high place of sacrifice."—(Wilson)

[1] मध्वा यत् कर्त्वमभवदभीके कामं कृण्वाने पितरि युवत्यां ।
मनानग्रेतो जहतुर्वियंता सानौ निषिक्तं सुकृतस्य योनौ ॥

—*Ṛg-Veda*, X, 61, 6.

The astronomical phenomenon was observed in mid-heaven or on the meridian of the observer. We have a star called *Prajāpati* in the *Sūrya Siddhānta*, viii ; 20, which is identified by Burgess in his translation, with δ *Aurigae*, and his identification is faultless. We have also the *Mṛgavyādha* (*Sirius*) of which another Vedic name was *Śvan* (or the Dog), and *Rohiṇī* is of course the star *Aldebaran*.

The legend divested of allegory is that the stars δ *Auriga* and α *Tauri* or *Aldebaran* were observed to cross the meridian almost together. This was understood by the gods as the most improper conduct on the part of Prajāpati, and the god Rudra, then born and stationed at the star *Sirius* pierced Prajāpati (δ *Auriga*); his three-pointed arrow was most probably the line through θ, β and δ *Auriga*, which have almost the same celestial longitude. Again the star *Sirius*, the three stars at *Orion*'s belt and α *Tauri* or *Aldebaran* are very nearly in the same line. Here Rudra's three-pointed arrow may also mean this latter line through *Orion*'s belt. The word '*trikāṇḍa*' does not really mean three pointed, but perhaps having three joints, just as the joints are seen on a bamboo pole or in a sugar cane. If we take the latter meaning for the arrow of Rudra, it would not reach *Prajāpati* or δ *Auriga*, and Rudra would be a bad marksman, for piercing either *Prājāpati* or *Rohiṇī*.

We have thus to look for the time when *Prajāpati* or δ *Auriga* and α *Tauri* or *Aldebaran* had almost the same right ascension.

In 1935 A.D. the celestial positions of these stars were as follows :—

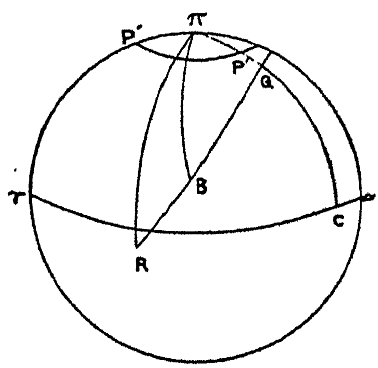
Star	Right Ascension	Declination
δ Auriga	$5^h\ 54^m\ 10{\cdot}398$	54° 16′ 55·23N
α Tauri	$4^h\ 32^m\ 11{\cdot}248$	16° 22′ 48·63N

and obliquity of the ecliptic = 23° 26′ 51″·86.

After transformation of the co-ordinates, we have the following celestial longitudes and latitudes for the year 1935 A.D.:

Star	Celestial longitude	Celestial latitude
δ Auriga	89° 0′ 35″	+30° 50′ 21″
α Tauri	68° 52′ 50″	−5° 28′ 19″

The difference in their celestial longitudes was thus 20° 7′ 45″ in 1935 A.D. In the following calculations the latitudes of the stars are supposed to remain constant throughout.



In the above figure of the celestial sphere, let π be the pole of the ecliptic, PP′ the path of the celestial pole round π, R and B the positions of the stars α *Tauri* and δ *Auriga* respectively in the year 1935 A.D.

(1) In the triangle πRB, the arc πR=90°+5° 28′ 19″, πB= 59° 9′ 39″ and the angle RπB=20° 7′ 45″

Hence the angle πRB becomes = 26° 42′ 47″.

Now from π draw πPQ perpendicular to the arc RB extended, then πQ becomes = 26° 34′ 54″.

Thus there was or is no possibility of these two stars to have exactly the same right ascension at any past or future date, as πP can never be equal to or greater than 26° 34′ 54″

We can thus determine only the time of their nearest approach to an equality of their right ascensions.

At this time the position of the summer solstitial colure was the arc πPQC.

We readily find the angle RπQ = 92° 44′ 50″

Hence the longitude of summer solstitial colure of the date in question was 92° 44′ 50″ *plus* the celestial longitude of α *Tauri* for the year 1935 A.D.

This was thus

$$= 92° 44' 50'' + 68° 52' 50''$$
$$= 161° 37' 40''$$

The shifting of the solstices thus was 71° 37′ 40″ from which the number of years elapsed till 1935 becomes 5177 and the year or the date was thus 3243 B.C. in which the right ascension of α *Tauri* or *Rohiṇī* was almost equal to that of δ *Auriga* or *Prajāpati* and the right ascensions of the two stars were also zero near about the same time.

The time when δ *Auriga* had its right ascension = 0, its longitude was = 15° 28′ 40″, taking the value of the obliquity of the ecliptic to be 24° 5′. In 1935 the longitude of δ *Auriga* was 89° 0′ 35″, so the increase in the celestial longitude of the star till 1935 A.D. = 73° 31′ 55″, which represents a lapse of about 5329 years, or the year was about 3395 B.C.

Similarly when the right ascension of α *Tauri* was = 0, its longitude was = −2° 27′ 1″ (ϖ = 24° 3′)

Hence the increase in the celestial longitude of the star till 1935 A.D. = 71° 19′ 51″ representing a lapse of about 5167 years and the date was thus 3233 B.C.

The above two dates, *viz.*, 3395 B.C, and 3233 B.C. had between them an interval of 162 years. The right ascensions of these stars at these two dates are tabulated below:—

Stars	R. A. in 3395 B.C.	R. A. in 3233 B.C.
δ Auriga	0° 0′ 0″	+2° 2′ 38″
α Tauri	−2° 0′ 28″	0° 0′ 0″

There are two more points in this connection which have to be considered :—(1) The time determined, *viz.*, 3243 B.C. being about the time when the equinoxial colure passed through the star α *Tauri*, the question now arises what had the Vedic Hindus to do with the position of the equinoctial colure in their sacrificial year ; and (2) why have we identified the star δ *Auriga* of the 4th magnitude with *Prajāpati*, or why we did not take α *Auriga* which is a star of the 1st magnitude and which is called *Brahmahṛdaya* or the "heart of Brahmā."

With regard to the first point raised above we can say that the Vedic Hindus had a special sacrifice which was called *Śyāmāka Āgrayaṇa* the first millet harvest sacrifice which is thus described in the *Kauṣītaki Brāhmaṇa*,[1] IV, 12.

"Next as to *Āgrayaṇa*. He who desires proper food should sacrifice with the *Āgrayaṇa*. In the rains[2] when the millet harvest has come, he gives orders to pluck millet.

The new moon night which coincides with that time, on it should he sacrifice and then offer this sacrifice. If he is a full-moon sacrificer, he should sacrifice with this and then offer the full-moon sacrifice. If again he desires a *nakṣatra*, he should in the first half of the month look out for a *nakṣatra* and offer under the *nakṣatra* which he desires."

—(Keith)

We have not any interest in discussing the small inaccuracies which may be found in Keith's translation; but we take that the rendering is substantially correct. The *Śyāmāka śasya* or the millet is reaped in the month of Bhādra (lunar new-moon ending), which may begin from August, 19 to Sept. 15, and the full-moon of Bhādra oscillates between Sept. 2 and Oct. 1. It is thus quite possible for the full-moon of Bhādra to fall on the

[1] अथात आग्रयणस्याग्रयणेनान्नाद्यकामो यजेत। वर्षास्वागते श्यामाकसस्ये श्यामाकान् उद्धरत्वा आह। तस्मिन् कालेऽमावास्योपसम्पद्यते तयेष्ट्वाऽथैतयेष्ट्या यजेत। यदि पौर्णमास्ये तयेष्ट्वाथ पौर्णमास्येन यजेत। यद्यु नक्षत्रमुपेप्सेत् (मपुप्सेत्) पूर्वपक्षे नक्षत्रमुदीक्ष्य यस्मिन् नक्षत्रे (कल्याणनक्षत्रे) कामयेत तस्मिन् यजेत॥

[2] The rains last for four months commencing from the day of summer solstice in North India.

23rd of September as it did in the year 1934 A.D., it fell on Sept. 25 in 1923, on Sept. 22 in 1926. Hence the full-moon of Bhādra is, what is illustrated as the Harvest moon in astronomy and the *Śyāmāka Āgrayaṇa* full-moon was such a Harvest Moon. This *Āgrayaṇa* full-moon or the harvest moon is also mentioned in the *Mahābhārata* as the full-moon at the *Kṛttikas* (*vide M. Bh., Vana.* 82, 31-32 ; 82. 36-37 ; 84. 51-52 ; *Anuśāsana*, 25, 46). It appears that the Vedic Hindus had to use the autumnal equinoctial day in their sacrificial calendar, and the autumnal equinoctial day is more in evidence than the vernal equinoctial day.

It was on such a full-moon night when the sun was at the autumnal equinox, that the conjunction of *Prajāpati* and *Rohiṇī* (*i.e.* of δ *Auriga* and α *Tauri*) by the almost simultaneous crossing of the meridian line was observed. The date as we have ascertained was about 3245 B.C. when the vernal equinox colure passed almost straight through the star α *Tauri*. Now-a-days a full-moon near the star *Rohiṇī* (*Aldebaran*) happens on the 2nd December. From the 23rd of September to the 2nd of December the number of days=70, and at the rate of 74 years for the shifting of the equinoxes by one day, the time elapsed becomes 5180 years, the date becomes nearly the same 3245 B.C. The astronomical phenomenon was that at the full-moon, δ *Auriga* and α *Tauri*, almost simultaneously were observed to cross the meridian about the date found here at the place of the observer.

As to the second point why we have taken δ *Auriga*, a star of the 4th magnitude for *Prajāpati*, I would say that it is this star that is called so in the *Sūrya-Siddhānta* [1] which has I trust faithfully brought down the tradition to our own times. Again δ *Auriga* represents the head of *Auriga*, and it was not improbable that this same constellation used to be called Brahmā in the Vedic literature. The star may now be one of the fourth magnitude, it was perhaps not so inconspicuous in those days, *viz.*, in the third millennium B.C. If the whole solar system has been sweeping through space towards either the constellation *Hercules*

[1] *Sūrya-Siddhānta*, viii, 20.

or *Lyra*, and the stars in the constellation *Auriga* being almost diametrically opposite have been steadily growing less and less bright. Hence δ *Auriga* was not so inconspicuous before the third millennium B. C. The tradition preserved in the modern *Sūrya-Siddhānta* that Prajāpati itself is the star δ *Auriga* cannot thus be ignored.

Again the star α *Auriga* is called in the *Sūrya-Siddhānta* *Brahmahṛdaya* or the "*Heart of Brahmā*," and the Mahābhārata legend tells us that "Rudra then pierced the heart of *Yajña* (*Prajāpati*) with a dire (*raudra*) arrow, and *Yajña* (or the Sacrifice) fled therefrom in the form of a deer with *Agni* (β *Tauri* ?). That Yajña (Sacrifice or Prajāpati) in that form reached the heavens and shone there, being followed by Rudra."[1] Here *Rohiṇī* or *Aldebaran* does not come in. We have to consider the case of the two stars which have almost the same celestial longitude ; and these were for 560 A.D. equal to 62° 32′ and 61° 50′ respectively of β *Tauri* and α *Auriga* ; their celestial latitudes were 5° 22′ N and 22° 52′ N. This is rather confusing, no astronomical interpretation is possible and the Mahābhārata legend is quite unintelligible. The legend of Prajāpati and Rohinī astronomically interpreted does not yield the V. Equinox at *Mṛgaśirās* as was supposed by Tilak in his *Orion*, pp. 20 *et. seq.*

[1] *M. Bh.*, *Sauptika Parvan*, 18, 13-14 :

[1] ततः स यज्ञं विव्याध रौद्रेण हृदि पत्रिणा ।
अपक्रान्तस्ततो यज्ञो मृगो भूत्वा सपावकः ॥
स तु तेनैव रूपेण दिवं प्राप्य व्यराजत ।
अन्वीयमानो रुद्रेण युधिष्ठिर नभःस्थले ॥

CHAPTER XIII

VEDIC ANTIQUITY

Solstice Days in Vedic Literature and Yajurveda Antiquity

In the present chapter it is proposed to exmine first if the Vedic Hindus knew of any method for determining the day of the winter or of his summer solstice, and secondly to interpret the various statements as to the solstice days as found in the *Kauṣitaki Brāhmaṇa*, the *Yajurveda* and the *Mahābhārata* and to settle the approximate dates in Vedic chronology as indicated by these statements.

(I) *The method of finding the solstice days in Vedic Literature.*

The method of the Vedic Hindus for determining the solstice days is thus expressed in the following passage from the *Aitareya Brāhmaṇa*[1]:

एकविंशमेतदहरुपयन्ति विषुवन्तं मध्ये संवत्सरस्य इति। एतेन वै देवा एकविंशेनाऽदित्यं स्वर्गाय लोकायादयच्छन् इति। स एष इत एकविंशः इति। तस्य दशावस्तादहानि दिवाकीर्त्त्यस्य भवन्ति दशपरस्तान् मध्य एष एकविंश उभयतो हि वा एष विराजि प्रतिष्ठितस्तस्मादेषोन्तरेमाँल्लोकान् यन्न व्यथते इति।

तस्य वै देवा आदित्यस्य स्वर्गाल्लोकादवपातादविभयुस्तं त्रिभिः स्वर्गैर्लोकैरवस्तात् प्रत्युत्तभ्नुवन् स्तोमा वै त्रयः स्वर्गाल्लोकास्तस्यपराचोऽतिपातादविभयुस्तं त्रिभिः स्वर्गैर्लोकैः परस्तात् प्रत्यस्तभ्नुवन्। स्तोमा वै त्रयः स्वर्गा लोकास्तत्त्रयोऽवस्तात् सप्तदशा भवन्ति त्रयः परस्तान् मध्य एष एकविंश उभयतः स्वरसामभिधृतः उभयतो हि वा एष स्वरसामभिधृत स्तस्मादेषोऽन्तरेमाँल्लोकान् यन्न व्यथते। इति।

Sāyaṇa has failed in his exposition of this passage which relates to observational astronomy, and no one who is unacquainted with this branch of science can possibly bring out any sense

[1] *Aitareya Brahmaṇa*, 18, 18, quoted by S. B. Dikṣita in his भारतीय ज्योतिःशास्त्र, p. 47.

of it. We follow Keith generally with some modifications in the translation which is given below:

'They perform the *Ekaviṁśa* day, the *Viṣuvān*, in the middle of the year; by this *Ekaviṁśa* day the gods raised up the sun towards the world of heaven (the highest region of the heavens, *viz.*, the zenith). For this reason this sun (as raised up) is (called) *Ekaviṁśa*, Of this *Ekaviṁśa* sun (or the day), the ten days before are ordained for the hymns to be chanted during the day; the ten days after are also ordained in the same way; in the middle lies the *Ekaviṁśa* established on both sides in the *Virāj* (a period of ten days). It is certainly established in the *Virāj*. Therefore he going between (the two periods of 10 days) over these worlds, does not waver.'

'The gods were afraid of this *Āditya* (the sun) falling from this world of heaven (the highest place in the heavens); him with three worlds (diurnal circles) of heaven (in the heavens) from below they propped up; the *Stomas* are the three worlds of heaven (diurnal circles in the heavens). They were also afraid of his falling away upward; him with three worlds of heaven (diurnal circles in the heavens) form above they propped up; the *Stomas* are the three worlds of heaven (diurnal circles in the heavens) indeed. Thus three below are the *saptadaśas* (seventeen), three above; in the middle is the *Ekaviṁśa* on both sides supported by *Svarasāmans*. Therefore he going between these *Svarasāmans* over these worlds does not waver.'

The Vedic year-long sacrifices were begun in the earliest times on the day following the winter solstice. Hence the *Viṣuvān* or the middle day of the year was the summer solstice day. The above passage shows that the sun was observed by the Vedic Hindus to remain stationary, *i.e.*, without any change in the meridian zenith distance for 21 days near the summer solstice. The argument was this that if the sun remained stationary for 21 days, he must have had 10 days of northerly motion, 10 days of southerly motion, and the middle (eleventh) day was certainly the day of the summer solstice; hence the sun going over these worlds, in the interval between the two periods of 10 days on either side, did not 'waver.' Thus from a rough observation,

the Vedic Hindu could find the real day of the summer or winter solstice.

The next passage from the *Aitareya Brāhmaṇa* (not quoted) divides the *Virāj* of 10 days thus : 10=6+1+3 ; the first 6 days were set apart for a *Ṣaḍaha* period, followed by an *atirātra* or extra day and then came the three days of the three *Stomas* or *Svarasāmans*. The *atirātra* days before and after the solstice day were respectively styled *Abhijit* and *Viśvajit* days. It may thus be inferred that the Vedic Hindus by more accurate observation found later on that the sun remained stationary at the summer solstice for 7 and not 21 days.

Question may now be asked how could they observe that the sun remained stationary for 21 days and not for 23, 27, 29, or 31 days. This depended on the degree of accuracy of observation possible for the Vedic Hindus by their methods of measurement. They probably observed the noon shadow of a vertical pole.[1] If we assume that the observation was made at the latitude of Kurukṣetra (about 30° N) and when the obliquity of the ecliptic was about 24° 15′, and the height of the pole was taken equal to, say, 6 ft., then :

(*a*) When the sun had a longitude of 80°, the length of the noon-shadow = 7·44 in.

(*b*) When the sun had a longitude of 87°, the length of the noon-shadow = 6·98 in.

(*c*) When the sun had a longitude of 90°, the length of the noon-shadow = 6·93 in.

Now 7·44 in. − 6·93 in. = 0·51 in. and 6·98 in. − 6·93 in. = 0·05 in.

Hence by using any sort of measuring rods, they could perhaps easily discern a change in the noon-shadow of about half an inch, but a difference of ·05 in. was, of course, quite impossible of perception with them. They could thus infer that the sun remained stationary at the summer solstice for 7 days when they used any measuring rods and when they used rougher

[1] Another method possible for the Vedic people was to observe the sun's amplitude near about the S. Solstice day, and this was found to remain stationary for 21 days.

methods they could conclude that the sun remained stationary for 21 days at the summer solstice.

At the winter solstice, the corresponding lengths of the noon-shadow would be 8 ft. 3·46 in., 8 ft. 4·84 in. and 8 ft. 4·94 in. respectively. The changes in the length of the shadow were consequently 1·38 in. and 0·10 in. respectively.

It should thus be clear that the Vedic Hindus knew how to determine the summer or the winter solstice day. When they found that the sun apparently remained stationary at the solstice for 21 days, the true solstice day was the 11th and when they found that the sun remained stationary for 7 days, they took the 4th day as the real solstice day.[1]

This finishes the first part of this chapter. We now pass on to consider how the Vedic Hindu stated his day of the winter solstice in successive ages. Some of these statements are the following :—

(*a*) The sun turned north on the new-moon of *Māgha* ended.

(*b*) ,, ,, ,, ,, ,, ,, last quarter of *Māgha*.

(*c*) ,, ,, ,, ,, ,, ,, full-moon of *Māgha*.

(*d*) ,, ,, ,, ,, one day before full-moon of *Māgha*.

(*e*) ,, ,, ,, ,, on the new-moon of *Māgha* begun.

[1] The other method of determining the solstice day is described in *Bṛhat Saṁhitā* of Varāhamihira. Chap. III, 3 :—

दूरस्थचिह्नवेधादुदयेऽस्तमयेऽपि वा सहस्रांशोः ।
छायाप्रवेशनिर्गमचिह्नैर्वा मण्डले महति ॥३॥

'The solstice day may be determined by observing the coincidence of the sun at the time of rising or setting with a distant sign-post or by the marks of entrance or exit of the tip of the shadow of a gnomon in a large horizontal circle (having for its centre the foot of the gnomon).' Here two methods are described by Varāhamihira in the first of which the sun's amplitude at sunrise or sunset is to be observed. If the Vedic Hindus followed this method, they could perhaps observe the sun to remain stationary, *i.e.*, without any appreciable change of amplitude, for 21 days near the solstices. It does not appear probable that the second method was followed by the Vedic Hindus. In this connection the method followed by the Druids of the ancient Britons, with heir *cromlechs* (stone circles) as are seen in the Salisbury plains in England, for determining the solstice days may be compared. The first method described by Varāhamihira readily led to the observation of the heliacal rising of stars in different seasons as has been found in the *Vedas*.

As we shall see later on, these statements as to the day of the winter solstice occur in Vedic literature. The month of *Māgha* (lunar) may begin now-a-days from the 15th of January to the 11th of February. What then is the meaning of this month of *Māgha* as referred to in the above statements? Why should the sun's turning north be connected with a particular phase of the moon of such a movable month ? Unless and until we can answer the above questions satisfactorily, we cannot hope to interpret any of the above statements.

We have very carefully considered the above questions and we may state our finding in the following way:

The Vedic Hindus did not have a sidereal reckoning of the year ; they followed a reckoning by lunar months of which 12 or 13 formed the year ; in their reckoning the month of *Māgha*, as it came every year, did not begin in the same part of the sidereal or the tropical year as it does not begin now also. If they had in use a sidereal calendar, they could state the solstice days by exact days of such a calendar. Unfortunately this they had not. They found out a particular lunar month of *Māgha* (not occurring every year) to fix the beginning or the end of the five-yearly luni-solar Vedic cycle, and they stated the solstice days in reference to the phase of the moon of such a month of *Māgha*. The winter solstice day was the beginning of the Vedic five-yearly cycles or *Yugas* and *Sāṁvatsara* or year-long Vedic sacrifices were begun in the earliest times also from the day of the winter solstice. It is thus necessary for us to find the true meaning of this peculiar month of *Māgha*: how it began and what were its characteristics.

Meaning of the Month of Māgha for Vedic Cycles

As to the beginning of the month of *Māgha* which was used for starting the Vedic five-yearly cycles the *Jyautiṣa Vedāṅgas* (1400 B.C.) say :

स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ ।
स्यात् तदादियुगं माघस्तपः शुक्लोऽयनं ह्युदक् ॥६॥

'When the sun, the moon and the *Dhaniṣṭhās* (*Delphinis*) ascend the heaven together, it is the beginning of the *Yuga* (*i.e.*,

five-yearly luni-solar cycle), of the month of *Māgha* or *Tapas* of the light half and of *the sun's northerly course*.' Hence this month of *Māgha* as used for starting the Vedic cycles must begin with the new-moon at *Delphinis*. In the *Jyautiṣa Vedāṅga* time the day of the very beginning of a such a *Māgha* was the day of the winter solstice and thus it marked the beginning of the tropical month of *Tapas*, the first of winter.

As to the time when the use of this month of *Māgha* was accepted for making the Vedic calendar, we have the following passage from the *Mahābhārata*:

'अभिजित् स्पर्द्धमाना तु रोहिण्याः कन्यसी स्वसा ।
इच्छन्ती ज्येष्ठतां तात तपस्तप्तुं वनं गता ॥
तत्र मूढोऽस्मि भद्रं ते नक्षत्रं गगनाच्च्युतम् ।
कालं त्विमं परं स्कन्द ब्रह्मणा सह चिन्तय ॥
धनिष्ठादिस्तदा कालो ब्रह्मणा परिकल्पितः ।
रोहिणी ह्यभवत् पूर्व्वम् एवं संख्या समाऽभवत् ॥
एवमुक्ते तु शक्रेण कृत्तिकास्त्रिदिवं गताः ।
नक्षत्रं सप्तशीर्षाभं भाति तद्वह्निदैवतम् ॥

M. Bh., Vana, 230, 8-11.

"Lady *Abhijit* (*i.e.*, α*Lyra*), the younger sister of *Rohiṇī*, being jealous of her, has gone to the forest to perform austerities with the desire of attaining the position of the elder. I am thus confounded at this incident as one *nakṣatra* has been deflected from heavens. Hence O Skanda, please find this time in consultation with Brahmā." Then Brahmā fixed the time, beginning from the *Dhaniṣṭhās*, and *Rohiṇī* (α *Tauri* or *Aldebaran*) became the first star. In this way the number of *nakṣatras* became proper (*Sama*). When Indra thus spoke to Skanda, the *Kṛttikās* flew to the heavens as the *nakṣatra* (star group) with seven heads, as it were, and it still shines as the one of which the presiding deity is *Agni* (Fire).'

The passage quoted above shows that it was Brahmā, a person of very high antiquity whose name was forgotten, who started the reckoning of time from the new-moon at the *Delphinis*, when *Rohiṇi* became the first star, and the *Kṛttikās* rose very probably exactly at the east. Here we have the time when the Vedic

five-yearly luni-solar cycles came to be started with reference to the month of *Māgha*.

Now in Vedic literature *Rohiṇī* means two stars, *viz.*, *Rohiṇī* proper (*Aldebaran*) or *Jyeṣṭhā* (*Antares*).[1] For 1931 A.D. their longitudes were 68° 49′ and 248° 48′ according to our calculation.[2] Hence these stars differ in longitude by almost 180° degrees, and had respectively the longitudes of 0° and 180° at about **3050 B.C.**[3]

This was the approximate date when the month of Māgha with its beginning with a new-moon at Delphinis was agreed upon as the standard month with reference to which the five-yearly Vedic luni-solar cycles were started and intercalary months were determined. It was about this time that the number of *nakṣatras* (lunar mansions) was fixed at 27 by rejecting *Abhijit* (α*Lyra*). It is here not necessary for us to attempt an explanation of the rivalry between either of the *Rohiṇīs* and *Abhijit*.

We have up to now settled that one feature of this standard month of *Māgha* was that it should begin with a new-moon near the *Delphinis*. Another feature which follows from this is that it should have the full-moon near the star *Maghā* or *Regulus*, as the moon takes about 14·7 days, at the mean rate, to pass from β *Delphinis* to α *Leonis* or *Maghā*.

The third feature of this standard month of *Māgha* was that at its last quarter (*aṣṭakā*), the moon should be conjoined with *Jyeṣṭhā* or *Antāres* as the *Āpastamba Gṛhya Sūtra* says:[4]

या माघ्याः पौर्णमास्या उपरिष्टाद् व्यष्टका तस्याष्टमी ज्येष्ठया सम्पद्यते तामेकाष्टकेत्याचक्षते ।

[1] *Taittirīya Saṁhitā*, 4, 4, 10.

[2] According to Burgess these stars had the celestial longitudes of 49° 45′ and 229° 44′ in 560 A.D. Translation of the *Sūrya Siddhānta*, Calcutta University Reprint, p. 243.

[3] The conjunction of *Aldebaran* with the full-moon could perhaps only be observed by their simultaneous meridian passages on the equinoxial day in the Vedic times. The celestial pole of the time was very near to α *Draconis*. The other possible method of observing the conjunction of the full-moon with *Aldebaran* on the equinoxial day was by joining the pole star with the moon and Aldebaran. In both these methods it was the R. A. which was really taken equal to Zero, and the date for that comes out to be 3233 B.C.

[4] *Āpastamba Gṛhya Sūtra*. viii, 81, 19.

'The *Vyaṣṭakā* which comes after the full-moon at *Maghā* (*Regulus*), has its eighth day (of the dark half) or last quarter with the moon at the star *Jyeṣṭhā* or *Antares* ; that is called *Ekāṣṭakā*.'

The moon takes at the mean rate 7·545 days or roughly a quarter of a synodic month to pass from *Regulus* to *Antares*.

Thus we come to the conclusion that the Vedic standard month of *Māgha*, in reference to which the Vedic five-yearly luni-solar cycles were started and winter solstice days in successive ages were determined and stated, had three characters, *viz.*, (1) New-moon at *Delphinis*, (2) Full-moon at *Regulus*, and (3) Last quarter at *Antares*. This month of *Māgha* did not and also does not come every year. We shall henceforth call this month the *Vedic Standard month of Māgha*.

The Vedic Standard Month of Māgha in Present Times

We can now ascertain how and when such a standard *Māgha* occurred or may occur in our own times. For 1931 A.D., *β Delphinis* had a longitude of 315° 23′, *α Leonis* 148° 53′, *α Scorpionis* or *Antares* 248° 48′ nearly. Hence this standard month of *Māgha* should begin about the 5th February, should have the full-moon about the 18th February, and the last quarter about the 28th February. If we look for such a month coming in our own times, we had it as shown below :—

Year	Beginning New-moon	Full-moon	Last quarter	Ending New-moon
1924	Feb. 5	Feb. 20	Feb. 27	Mar. 5
1927	Feb 2	Feb. 16	Feb. 24	Mar. 3
1932	Feb. 6	Feb. 22	Feb. 28	Mar. 7
1935	Feb. 3	Feb. 18	Feb. 26	Mar. 5

The Vedic standard month of *Māgha* is thus not strictly unique in its position in the sidereal year. All points considered we are inclined to take that this *Māgha* happened in our time in 1924 A.D. from the 5th February till the 5th March. This year and this month we shall use as our gauge year and month

in interpreting the different statements of the days of the winter solstice as occurring in Vedic literature.[1]

(ii) *Statements of Solstice Days in Vedic Literature*

We are now going to state and explain the references from the *Brāhmaṇas* and other works which either directly state or indicate the winter solstice day of the successive Vedic periods.

(A) The first reference is from the *Kauṣītaki Brāhmaṇa*, and it was first found by Weber:

स वै माघस्यामावस्यायामुपवसत्युदङ्ङावत्स्यन्नुपेमे वसन्ति प्रायणीयेनातिरात्रेण यक्ष्यमाणास्तदेनं प्रथममाप्नुवन्ति तं चतुर्विंशेनारभन्ते तदारम्भणीयस्यारम्भणीयत्वं स षण्मासानुदङ्ङेति तमूर्ध्वैः षड्हैरनुयन्ति स षण्मासानुदङ्ङित्वा तिष्ठते दक्षिणावर्त्स्यन्नुपेमे वसन्ति वैषुवतीयेनाह्ना यक्ष्यमाणास्तदेनं द्वितीयमाप्नुवन्ति स षण्मासान् दक्षिणैति तमावृत्तैः षड्हैः अनुयन्ति स षण्मासान् दक्षिणेत्वा तिष्ठते उदङ्ङावर्त्स्यन्नुपेमे महाव्रतीयेनाह्ना यक्ष्यमाणास्तदेनं तृतीयमाप्नुवन्ति तं यत्त्रिराप्नुवन्ति त्रेधाविहितो वै संवत्सरः संवत्सरस्यैवाप्त्यै तदुतैषाऽपि यज्ञगाथा गीयते ।

अहोरात्राणि विदधद् ऊर्णा वा इव धीर्यः
षण्मासा दक्षिणा नित्यः षडुदङ्ङेति सूर्य्यः ।

इति षड्ढ्येष उदङ्मासानेति षड् दक्षिणा तद्धै न तस्मिन् काले दीक्षेरन्ननागतं सस्यं भवति दहरकाण्यहानि भवन्ति संवेपमाना अवभृथादुदायन्ति तस्मादस न दीक्षेरं-श्चैत्रस्यामावस्याया एकाह उपरिष्टाद् दीक्षेरन् आगतं सस्यं भवति महान्त्यहानि भवन्त्य-संवेपमाना अवभृथादुदायन्ति तस्मादेतत् स्थितम्[2] ।

This passage has thus been translated by Keith in his *Ṛg-Veda Brāhmaṇas*:

'On the new-moon of *Māgha* he rests, being about to turn northwards; these also rest, being about to sacrifice with the introductory *atirātra*; thus for the first time they obtain him; on him they lay hold with the *caturviṁśa*; that is why the

[1] The year 1924 A.D. is also similar to the year 80 A.D. of which the 1st day of *Māgha* was the epoch of the *Paitāmaha Siddhānta* of the *Pañcasiddhāntikā* of Varāhamihira. The interval of 1844 sidereal years = 673532·73 da and 22808 lunations = 673533 65 da. The difference is only about a day,

[2] *Kauṣītaki Brāhmaṇa*, xix, 3.

laying hold has its name. He goes north for six months ; him they follow with six-day periods in forward arrangement. Having gone for six months he stands still, being about to turn southwards ; these also rest, being about to sacrifice with the *Viṣuvant* day ; thus for the second time they obtain him. He goes south for six months ; they follow him with six-day periods in reverse order. Having gone south for six months he stands still, and they about to sacrifice with the *Mahāvrata* day obtain him for the third time. In that they obtain him thrice, the year is in three ways arranged. Verily it serves to obtain the year. With regard to this, this sacrificial verse is sung,

> Ordaining the days and nights,
> Like a cunning spider,
> For six months south constantly,
> For six north the sun goeth.

For six months he goes north, six south. They should not consecrate themselves at this time ; the corn has not arrived, the days are short, shivering they come out from the final bath (*avabhṛtha*). Therefore they should not consecrate themselves at this time. They should consecrate themselves one day after the new-moon of *Caitra* ; the corn has come, the days are long, not shivering they come out from the final bath. Therefore that is the rule'.

Here it is definitely stated that on the the new-moon of *Māgha* the sun reached the winter solstice.[1] This new-moon is without any doubt that new-moon with which *Māgha* ended. The definition or meaning of this month of *Māgha* has been found before. This statement shows that the 5th of March, 1924 A.D., was the true anniversary of this determination of the winter solstice. Now on the 5th March, 1924, G. M. noon, the sun's mean longitude was

$$= 342° \; 57' \; 46''$$
$$= 342° \; 58' \quad \text{to the nearest minute.}$$

This longitude was near to 270° in the year of this determination of the solstice day. It shows a shifting of the solstices by

[1] This is perhaps the oldest tradition of the solstice day as recorded in this *Brāhmaṇa*.

about 72° 58′, representing a lapse of about 5,268 years, till 1924 A D. But we have yet to allow for the sun's equation. Now in 52·44 centuries before 1900 A.D., the longitude of the sun's apogee was = 11° 30′ nearly and the eccentricity of the solar orbit was about ·018951. Hence the sun's equation for the mean longitude of 270° was, + 2° 8′ nearly.

This equation of + 2° 8′ is now applied to the mean longitude of the sun on the 5th March, 1924, at G. M. noon, *viz.*, 342° 58′. The result obtained, *viz.*, 345° 6′, was equal to 270° in the year of this determination of the winter solstice day. Hence the total shifting of the solstices becomes 75° 6′ nearly ; this indicates a lapse of 5,444 years till 1924 A.D., or the date of this determination of the solstice becomes near to 3521 B.C. Now as we want the year similar to 1924 A.D. as regards the moon's phases in relation to the fixed stars, the date arrived at requires a little adjustment. We have already obtained[1] the luni-solar cycles of 8, 19, 160, 1939, etc., years in which the moon's phases near to fixed stars repeat themselves.

Now 5444 = (1939 × 2 + 160 × 9 + 19 × 6 + 8) + 4. Hence elapsed years must now be taken as 5440 from which the required year comes out to be **3517 B.C.**

The sun then turned north in 3517 B.C. on the new-moon day of *Māgha* and the first year of the luni-solar cycle commenced from the said new-moon day. The question now is, 'how could they find the next winter solstice day.' They counted full 366 days or 12 months and 12 nights after which they estimated that the sun would reach the winter solstice. This sort of reckoning continued till the five-yearly cycle of 62 lunar months was exhausted. They then thought that the same type of *Māgha* returned, or they might check their reckoning in 3, 5, 8, 11 or 19 years by actual observation. Hence their predicted day of the winter solstice, when not checked by actual observation, was almost always in error, but perhaps was still within their limit of 21 days. Their observed solstice days, however, were always correct.

It may be asked how the Vedic year came to have 366 days or 12 lunar months + 12 nights. Generally this year is stated

1 Chapter 1, p. 27.

in many places to consist of 360 days only. How is this discrepancy to be explained ? In a half year there were the ordinary 180 days + 2 *atirātra* days, then came the *Viṣuvān*, the middle day of the year which belonged to neither half and then came the other half with 180 days + 2 *atirātra* days and lastly came the *Mahāvrata* day. In all, therefore, there were in the year 2(180+2)+2 or 366 days. Of the two *atirātras* of the northerly course, the first was the *Prāyaṇīya* and the second the *Abhijit* day. Similarly in the sun's southerly course, the first *atirātra* day was the *Viśvajit* day and the other had a suitable name. The Vedic year had thus 366 days or 12 lunations + 12 'nights.'[1]

One point more we want to settle is that when the Vedic year was taken to begin. The answer is now easy. The Vedic year normally began on the day following the winter solstice, and winter then began and lasted for two months. Winter was thus the first season of the year. There was next felt the difficulty of beginning the year-long sacrifices with the winter solstice day, as the time was unsuitable on the ground of its being extremely cold, as it was the non-harvesting time and as the days were then very short. Then rule was made to begin these sacrifices, not from the winter solstice day but full two months and one day or exactly 60 days later, when spring set in, or as the text says, ' One day after the new moon of *Caitra*. Thus the first season, though winter formerly, became spring in later reckoning (sacrificial year) and winter then became the last season of the year.

We have found out the year when the sun turned north on the new-moon of *Māgha* to have been 3517 B.C. by taking the standard month of *Māgha* as the one which happened from the 5th of February till the 5th of March, 1924 A.D. Our date is

[1] *Cf.* त्रिशत्यह्नां सषट्षष्टिरब्दो पञ्चर्त्तवोऽयने ।

Yājuṣa Jyautiṣa, 28.

" A year is three hundred with sixty six of days. In it there are five seasons and two courses (of the sun)."

In this connection it should be remembered that the *atirātra* days were not reckoned in the sacrificial calendar.

perhaps liable to shifting of about one or two centuries either way if we took the gauge year to be 1927 or 1932 A.D. This amount of possible shifting must be considered negligible at such a remote age. It is perhaps needless to point out that unless we can find out a correct interpretation of passages like above, no determination of time would be possible.

A question may yet be raised, if of the phrase 'the new-moon of *Māgha*,' the word *Māgha* means the full-moon ending month of *Māgha*. Our answer is that we have taken the month of *Māgha* as the new-moon ending not without any reason. In the *Jyautiṣa Vedāṁgas* we get the new-moon ending months alone; not a single verse in them can be interpreted to mean the full-moon ending months. In the case of the new-moon ending *Māgha*, we have established three distinctive peculiarities as already pointed out and that such a month of *Māgha* was associated with the winter solstice day and the starting of the Vedic five-yearly cycle or *Yuga*. The word *Māgha* as used in connection with the solstice days must have a definite meaning, *i.e.*, must mean more or less a unique synodic month not occurring every year. As to the full-moon ending *Māgha*, we have not yet discovered any unique meaning either from the *Jyautiṣa Vedāṁgas* or from other Vedic literature. Thus while we are so much in doubt as to the characters of a unique full-moon ending month of *Māgha*, the characters of the new-moon ending *Māgha* are very clear and well-pronounced. We thus consider it fruitless to speculate upon the characters of a Vedic full-moon ending unique *Māgha* to interpret the references like the above.[1] We now pass on to our next reference.

(B) This reference was quoted by Tilak in his '*Orion*' on pp. 44-45 and runs as follows [2]:

संवत्सराय दीक्षिष्यमाणा एकाष्टकायां दीक्षेरन्नेषा वै संवत्सरस्य पत्नी यदेकाष्टकै-तस्यां वा एष एतां रात्रिं वसति साक्षादेव संवत्सरमारभ्य दीक्षंत आर्त्तं वा एते संवत्सरस्याभिदीक्षंते य एकाष्टकायां दीक्षंते अन्तनामावृतू भवतः व्यस्तम् एते संवत्सर-स्याभिदीक्षंते य एकाष्टकायां दीक्षंते अन्तनामावृतू भवतः फल्गुनो पूर्णमासे दीक्षेरन्

[1] Further the full-moon ending *Māgha* cannot include the *Ekāṣṭakā* day as defined before. This is a serious defect of the full-moon ending months.

[2] *Taittirīya Saṁhitā*, VII, 4, 8, also *Tāṇḍya Brāhmaṇa*, V, 9.

मुखं वा एतत् संवत्सरस्य यत् फल्गुनी पूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षंते तस्यैकैव निर्या यत् साम्मेघ्ये विषुवान् सम्पद्यते चित्रापूर्णमासे दीक्षेरन् मुखं वा एतत् संवत्सरस्य यच्चित्रापूर्णमासो मुखत एव संवत्सरमारभ्य दीक्षंते तस्य न काचन निर्य्या भवति चतुरहे पुरस्तात् पौर्णमास्यै दीक्षेरन् तेषामेकाष्टकायां क्रयः सम्पद्यते तेनैकाष्टकां न छंवट् कुर्व्वन्ति तेषां पूर्व्वपक्षे सुत्या सम्पद्यते पूर्व्वपक्षं मासा अभिसम्पद्यन्ते ते पूर्व्वपक्ष उत्तिष्ठन्ति तानुत्तिष्ठत औषधयो वनस्पतयोऽनुतिष्ठन्ति तान् कल्याणी कीर्त्तिरनुत्तिष्ठत्यारत्सुरिमे यजमाना इति तदनु सर्व्वे राध्नुवन्ति ॥

This passage is from the *Taittirīya Saṁhitā*. The *Tāṇḍya Brāhmaṇa* has also almost the same passage with slight alterations as may be seen from Tilak's quotation in his '*Orion*.' We translate the above passage following him generally thus :

'Those who want to consecrate themselves for the yearly (year-long) sacrifice should do so on the *Ekāṣṭakā* day. This is the wife of the year what is called *Ekāṣṭakā* and he, the year, lives in her for this night. Those that consecrate on the *Ekāṣṭakā* truly do so in a distressed condition, as it is the season (winter) which is reckoned the last of the year. Thus those that consecrate on the *Ekāṣṭakā* do so in the reversed order as it marks the last season of the year. They should consecrate on the full-moon at the *Phalgus* as it is the mouth of the year. They thus begin the yearly (year-long) sacrifices from the very mouth ; but it has one defect that the *Viṣuvān* (the middle day of the year) falls in the rainy season. They should consecrate themselves at the full-moon near *Citrā* (*Spica* or α *Virginis*), as it is the beginning of the year. They thus begin the sacrifice from the very mouth of the year. Of this time there is no fault whatsoever. They should consecrate themselves four days before the full-moon (near *Citrā*). Their *Kraya* (*i.e.*, purchase of Soma) falls on the *Ekāṣṭakā* (here the last quarter of *Caitra*). Thereby they do not render the *Ekāṣṭakā* void (*i.e.*, of no consequence)). Their *Sutyā* (*i.e.*, extraction of Soma juice) falls in the first (light) half of the month. Their months (monthly sacrifices) fall in the first half. They rise (finish) in the first half. On their rising, herbs and plants rise after them. After them rises the good fame that these sacrificers have prospered. Thereon all prosper.'

The *Taittirīya Saṁhitā* here records three days of the winter solstice, the first two of which were traditional and the last one most likely belonged to the date of this book. These are:

(1) The Day of *Ekāṣṭakā*.
(2) The Day of the full-moon at the *Phalgus*.
(3) The Day preceding the full-moon of *Māgha*.

As in the *Kauṣītaki Brāhmaṇa* here is expressed a dislike for beginning the yearly sacrifices with the beginning of winter. Some centuries later than the tradition recorded in the *Kauṣītaki Brāhmaṇa*, it was observed that the winter solstice had preceded by nearly 8 days and fell on the *Ekāṣṭakā* day, *i.e.*, on the day of the last quarter, of the Standard month of *Māgha* on which the moon was conjoined with *Antares*. This day corresponded with the 27th February of 1924 A.D. of our time. Hence the date for this position of the winter solstice as obtained by observation comes out to have been **2934 B.C.**

It was about this time taken as a rule that the year-long sacrifices should be begun from the day of *Ekāṣṭakā*. But as this was the beginning of winter, it was considered unsuitable for the purpose chiefly owing to the extreme cold nature of the season which made the sacrificer shiver on coming out of the water after the bath of *avabhṛtha*. People then came to think that the yearly sacrifices should be begun according to an older tradition, *viz.*, that the day of the full-moon night near the *Phalgus* was the first day of the year. This day had been the day of the winter solstice many centuries before the time. The time when this was the position of the solstices was about 4550 B.C. We cannot be sure if at this high antiquity there was anything like the standard month of *Māgha* agreed upon.

[1] The *Pūrva Mīmāṁsā*, quotes the following traditional days for the *Gavāmayana* sacrifices :—
Full-moon days of *Māgha* or of *Caitra*, or the *Ekāṣṭakā*. The *Sūtras* are :
पौर्णमास्यामनियमोऽविशेषात् ॥२०॥ आनन्तर्यात् तु चैत्रीस्यात् ॥२१॥ माघी वैकाष्टकाश्रुतेः ॥२२॥
Pūrva Mīmāṁsā, VI, 5, 30-32,

The commentator Śavara quotes the *Taittirīya Saṁhitā* and the *Tāṇḍya Brāhmaṇa* for elucidation.

But the sacrificers who thought that the *Ekāṣṭakā* day was unsuitable for beginning the yearly sacrifices, calculated that the full-moon at the *Phalgus* would happen ¾th of a month or 22 days later, and that the middle day of the year would happen 22 days after the sun crossed the summer solstice—a day which was almost at the middle of the rainy season. Hence if they began the yearly (year-long) sacrifices at the beginning of spring *i.e.*, full two solar months or two lunar (synodic) months *plus* one day later, the *Viṣuvān* or the middle day of the sacrificial year would be the first day of autumn and there would be no inconvenience due to rainy weather on that day.

When the sun reached the winter solstice on the day of the last quarter of the standard month of *Māgha*, spring would begin full two synodic months *plus* one day later; consequently the day most suitable for beginning the yearly sacrifices would be the day following the *Caitrī Ekāṣṭakā* or the last quarter of *Caitra*. In its place the *Taittirīya Saṁhitā* recommends that yearly (year-long) sacrifices should be begun from the full-moon day of *Caitra* or *Citrā Paurṇamāsī* day. This being the beginning of spring, the winter solstice day was one day before the full-moon day of the standard month of *Māgha*.

This full-moon day of *Māgha* corresponded with the 20th February, 1924 A.D., and the year in which the winter solstice day fell on the full-moon day of *Māgha* was 2454 B.C.[1] The time indicated by the rule of the *Taittirīya Saṁhitā* becomes about **2446 B.C.** Judged by this latest tradition recorded in it, the date of the *Taittirīya Saṁhitā* should be about 2446 B.C. The other two traditions which it contains were true for about 4550 B.C. and 2934 B.C. respectively, of which the former is of doubtful value.

(c) In the *Mahābhārata*, there are several passages which directly or indirectly indicate that the nights of the full moons at the *Kṛttikās* and the *Maghās*, were respectively the autumnal

1 Eight years after 2454 B.C., the full moon of *Māgha* fell one day later, than the winter solstice day. In our finding this year, *viz.*, 2446 B.C was the year in which Yudhiṣṭhira began the *Aśvamedha* sacrifice. This has been fully discussed on page 32.

equinox and the winter solstice days and thus particularly auspicious for the performance of some religious observances:

(1) कार्त्तिकीं तु विशेषेण योऽभिगच्छति पुष्करम् ।
प्राप्नुयात् स नरो लोकान् ब्रह्मणः सदनेऽक्षयान् ॥[1]

'The man who goes to Puṣkara specially at the full-moon at the *Kṛttikās*, gets the blessed worlds for all times at the house of Brahmā.'

(2) कृत्तिकामघयोश्चैव तीर्थमासाद्य भारत ।
अग्निष्टोमातिरात्राभ्यां फलमाप्नोति मानवः ॥[2]

'A person reaching a holy bathing place at full-moons at the *Kṛttikās (Pleiades)* and the *Maghās (Regulus)*, etc. gets the merit of having performed respectively the *Agniṣṭoma* and the *Atirātra* sacrifices.'

Here it is significant that the difference in celestial longitudes of *Pleiades* and *Regulus* is very nearly equal to 90 degrees.

(3) दशतीर्थसहस्राणि तिस्रः कोट्यस्तथापरा ।
समागच्छन्ति माघ्यां तु प्रयागे भरतर्षभ ॥[3]

'At Prayāga (the confluence of the Ganges and the Jamuna) at the full-moon at the *Maghās*, three crores and ten thousand holy waters meet.'

(4) उर्वशीं कृत्तिकायोगे गत्वा चैव समाहितः ।
लौहित्ये विधिवत् स्नात्वा पुण्डरीकफलं लभेत् ॥[4]

'On the full-moon at *Kṛttikās*, if a man should go to the bathing place called Ūrvaśī and bathe in the Lauhitya (the river Brahmaputra), according to Śāstric rules with a devoted or prayerful mind, he would get the religious merit of having performed the *Puṇḍarīka* sacrifice.'

[1] M. Bh., *Vana*, 82. 31-32.
[2] M. Bh., *Vana*, 84, 51-52.
[3] M. Bh., *Anuśāsana*, 25, 35-36.
M. Bh., *Anuśāsana*, 25, 46.

We have already ascertained the time when the full-moon day of the standard month of *Māgha* was also the winter solstice day ; it was the the year *2454* B.C.[1] The Mahābhārata references quoted above show that the old observers could ascertain that at this time the vernal equinox was near to the *Kṛttikās* (*Pleiades*) and the summer solstice at the *Maghās* (or near to the star *Regulus*). This position of the equinoxes and the solstices was perhaps regarded as correct till up to 2350 B.C.

(D) We now come to a different sort of statement, not connected with the month of *Māgha*, from the *Brāhmaṇas* as to the beginning of the year expressed in terms of the fullness of the moon near to the *Phalgus* :

अथातश्चातुर्म्मास्यानां । चातुर्म्मास्यानि प्रयुञ्जानः फाल्गुन्यां पौर्णमास्यां प्रयुंक्ते। मुखं वा एतत् सम्वत्सरस्य यत् फाल्गुनी पौर्णमासी मुखमुत्तरे पुच्छं पूर्व्वे तद् यथा प्रवृत्तस्यान्तौ समेतौ स्यातामेवमेतौ संवत्सरस्यान्तौ समेतौ ।[2]

"Next as to the four-monthly sacrifices. He who prepares for the four-monthly sacrifices, begins on the full-moon night of the *Phalgunīs*. The full-moon night of the *Phalgunīs* is the beginning of the year ; the latter two (*uttare*) *Phalgus* are the beginning and the former two (*Pūrve*) the end (*i.e.*, *puccha* or the tail). Just as the two ends of what is round (*viz.*, the circle) may unite, so these two ends of the year are connected.'—(Keith)

We proceed to find the time indicated by the above passage on the hypothesis that this reference states the day of winter solstice and not the beginning of spring.

Winter Solsticial Point and Deduced Date

We have now to settle the exact indication of the winter solsticial point from the above *Brāhmaṇas* reference. The full-moon at the *Pūrva Phalgus* was the last night of the year, while the full-moon at the *Uttara Phalgus* the first night of the next

[1] Chapter II, *Mahābhārata, Kaliyuga*, pp. 40-42.

[2] *Kauṣītaki Brāhmaṇa*, 5, 1.

year. If we take the meaning that the sun reached the winter solstice at the full-moon at the *Pūrva Phalgus*, from such references, we arrive at the year 3293 B.C. On the other hand, if we take that the sun in opposition to β *Leonis* marked the winter solstice, the date comes out to be 3980 B.C. Here is produced a difference of about 700 years.

Now the *Vedic* full-moon nights were not *one* but *two* in a lunar month, the first of which was the *Anumati Paurṇamāsī* and the second was the *Rākā Paurṇamāsī*.[1] These two full-moon nights were consecutive. Hence we should take the full-moon occurring somewhere midway between the stars θ and β *Leonis* as indicative of the winter solstice day of this *Brāhmaṇa* period.

Now the celestial longitude of θ *Leonis* for 1931 A.D.
=162° 24′

and the celestial longitude of β *Leonis* for 1931 A.D.
=170° 41′

∴ The mean of the longitudes of these stars for 1931 A.D.
=166° 32′

Now on the 6th March, 1928, a full-moon happened at 12 hrs. 34 min. G. M. T. and the sun at G. M. noon had the longitude of 345° 40′ nearly. From which the total shifting of the solstices becomes 75° 40′ as a first approximation. The date comes out to be about 3550 B.C., which we understand to be earliest date for the inception of *Brāhmaṇa* literature as deduced from the above statement.

If the full-moon day of *Phālguna* be distinctly indicated as the beginning of Indian spring, in any of the *Brāhmaṇas*, the work in question must belong to a date of which the superior limit would go down to about 625 B.C. as will be set forth later on.

Conclusion

We have thus shown from the direct statements as found in the *Brāhmaṇas*, that the beginning of this class of literature and of the religious ceremonies prescribed in them began from

[1] *Aitareya Brāhmaṇa*, xxvii, 11, etc.

about 3550 B.C. The actual dates arrived at are tabulated below :

Date arrived at (approximate)	Reference or basis of date	Gauge year and date correct to W. S. Day
3550 B.C.	(D)	1928 A.D. 6th March
3517 B.C.	(A)	1924 A.D. 5th March
2934 B.C.	(B)	,, ,, 27th Feb.
2454 B.C. to 2350 B.C.	(C)	,, ,, 20th Feb.

The above dates indicated in the *Brāhmaṇas*, cannot be all classed as mere traditions. The year of the Bhārata battle falls within this range and was the year 2449 B.C. as has been established in Chapters I-III.

As to the references which use the month of *Māgha* for stating the solstice days, the gauge year could as well be 1927 A.D., and we cannot say if the Vedic Hindus did not sometimes use the type of *Māgha* which happened this year. This would tend to lower some of the dates as connected with *Māgha* by about 200 years. The reference (A) would indicate the date 3308 B.C. nearly 'when *Rohiṇī* became the first star.'[1]

This chapter is divided into two parts, in the first of which we have shown that the Vedic Hindus knew of a method of finding the solstice day of either description of any year. In the second half we have established that there was a standard month of *Māgha* in their statements of the solstice days in successive ages, and we have found out a set of dates extending from 3550 B.C. to 2350 B.C. during which some sort of Sanskrit literature known as the *Brāhmaṇas* began to be formed.

1 *M. Bh.*, *Vana*, 230, 8-11, quoted before.

CHAPTER XIV

BRĀHMAṆA CHRONOLOGY

Solar Eclipse in the Tāṇḍya Brāhmaṇa

As noticed by late Śaṅkara Bālakṛṣṇa Dīkṣita, in his भारतीय ज्योतिःशास्त्र, page 63 (1st. edn.), there are references to solar eclipses in five places in the *Tāṇḍya Brāhmaṇa* which are: (1) IV, 5, 2; (2) IV, 6, 13; (3) VI, 6, 8; (4) XIV, 11, 14-15, and (5) xxiii, 16, 2. In all these references it is stated that *Svarbhānu* struck the sun with darkness. Of these five references, in the two, *viz.*, VI, 6, 8 and XIV, 11, 14-15, it is said that it was Atri who destroyed the darkness from the front of the sun; in the remaining three references the removal of darkness from the sun is ascribed to the *Devas* or gods. Dīkṣita would take the word *'Devas'* to mean the "sun's rays." Whatever the meaning of the word *'Devas'* may be, it is clear that the references which speak of Atri as the person who dispelled the darkness that lay on the sun's disc, speak of the solar eclipse as described in the *Ṛg-Veda*, V, 40, the time of which has been already ascertained in Chapter IX as the 26th July, 3928 B.C. It is proposed in the present chapter to determine the date of this another eclipse of the sun as mentioned in the *Tāṇḍya Brāhmaṇa*, and understood as such by Dīkṣita. He had also found a reference to a solar eclipse in the *Śatapatha Brāhmaṇa*, V, 3, 2, 2 and which has been often quoted by subsequent writers. The three references of the *Tāṇḍya Brāhmaṇa* as to this special eclipse are the following:—

(a) "स्वर्भानुर्वा आसुरः आदित्यन्तमसाऽविध्यत्तं देवाः स्वरैरवस्पृण्वत् स्वरसामानो भवन्त्यादित्यस्य स्पृत्यै ।"

T. Br. IV, 5, 2.

(b) स्वर्भानुर्वा आसुरः आदित्यन्तमसाविध्यत्तस्य देवा दिवाकीर्त्यैं स्तमोऽपाघ्नन्

यद्दिवाकीर्त्यानि भवन्ति तम एवास्मादपघ्नन्ति रश्मयो वा एत आदित्यस्य यद्दिवाकीर्त्यानि रश्मिभिरेव तदादित्यं साक्षादारभन्ते ।

T. Br., IV, 6. 13.

(c) स्वर्भानुर्वा आसुरः सूर्यं तमसाऽविध्यत्तस्मै देवाः प्रायश्चित्तिमैच्छंस्त एता अविन्दंस्ताभिरस्मात्तमोऽपाघ्नन् ।

T. Br., XXIII. 16, 12.

These passages may be translated as follows:—

(*a*) "Svarbhānu born of Asura, struck the sun with darkness, which was dispelled by the gods with *Svaras* (hymns); hence the *Svarasāmans* are for the rescue of the sun"

(*b*) "Svarbhānu, the Asura, struck the sun with darkness. The gods removed this darkness by singing the *Divākīrtya* songs (*i.e.*, songs sung during the day time). Whatever are known as *Divākīrtyas*, are (the agents) for the destruction of darkness. These *Divākīrtya* songs are the rays of the sun. By the rays alone the sun is truly begun."

(*c*) "Svarbhānu, the Asura, struck the sun with darkness; for this the gods wanted to purify him and they got these *Svarasāmans*; by these they removed the darkness from the sun."

These passages all indicate that the solar eclipse in question happened on the *Viṣuvant* day, which means according to the *Taittirīya Saṁhitā* as "the middle day of the sacrificial year begun from spring." It meant the day on which the Indian rains ended and the Indian autumn began. To be more precise, it meant the day on which the sun's tropical longitude became 150°. According to the Vedic sacrificial calendar, there were the three *Svarasāman* days before the *Viṣuvant*, and three *Svarasāman* days after the *Viṣuvant*. On these seven days (including the *Viṣuvant*) the *Divākīrtya* songs were sung. We thus infer that the solar eclipse happened on the *Viṣuvant* day, *i.e.*, on the day on which the sun's tropical longitude was about 150° degrees.

What is here said in the *Tāṇḍya Brāhmaṇa* about *such a peculiar solar eclipse happening on the Viṣuvant day, must be a tradition of a past event only*. By exploring the period from −2553 A.D. to −1296 A.D. with the help of the eclipse cycles

deduced in Chapter IX on the "Solar Eclipse in the *Ṛgveda*, we find after a few trials that a solar eclipse took place in the year −2450 A.D. on Sept. 14, on which at G. M. T. 6 hrs or Kurukṣetra Mean Time 11-8 A.M., the lunisolar elements were :

Mean Sun	=	152°	12′	22″·35
,, Moon	=	148	32	16·30
Lunar Perigee	=	102	50	30·85
A. Node	=	143	51	1·32
Sun's apogee	=	27	1	51·86

Sun's eccentricity = 0·018331.

The full calculations of the circumstances of this solar eclipse are set forth in the Appendix. We briefly summarise them for the station Kurukṣetra :—

Date :—September, 14, −2450 A.D. (*i.e.*, 2451 B.C.)
Longitude of conjunction of Sun and Moon = 150° 18′ nearly
Time of beginning of the solar eclipse = 5-27 A.M., K.M.T.
,, ,, ending ,, ,, ,, = 7-4 ,, ,,
,, ,, nearest approäch of centres = 6-4 ,, ,,
Magnitude of the eclipse = 0·41 = 5 Indian units
Duration of eclipse = 1 hr. 37 m.
Time of Sunrise = 5-32 A.M., K.M. Time.
The eclipse began almost with the sunrise.

We have carefully examined the period from 2554 B.C. to 1297 B.C. and are satisfied that no other solar eclipse happened in this period with the sun's longitude at 150° nearly and which was visible at Kurukṣetra.

The *Tāṇḍya Brāhmaṇa* therefore records the solar eclipse on the *Viṣuvat* day in its references in IV, 5, 2 ; IV, 6, 13 and XXIII, 16, 12. It is not unlikely that the *Śatapatha Brāhmaṇa* also in V, 3, 2, 2 records the same traditional eclipse. We can not, however, by this finding settle if the *Tāṇḍya Brāhmaṇa* is to be dated earlier than the *Śatapatha Brāhmaṇa*. It will be shown later on that the *Jaiminīya Brāhmaṇa* and the *Tāṇḍya Brāhmaṇa* indicate a common date of about 1600 B.C.

APPENDIX

Calculation of the Solar eclipse mentioned in the Tāṇḍya Brāhmaṇa

Date—September, 14—2450 A.D. (2451 B.C.)
Julian day No. 826452.
Epoch : 6 A.M., G.M.T., *i.e.*, Kurukṣetra Mean Time 11-8 A.M.
(*i.e.*, 43·49 J. C. and 97 days before Jan. 1., 1900, G. M. Noon.)

Mean Luni-solar elements

Mean Sun	=	152°	12′	22″·35
Mean Moon	=	148	32	16·30
L. Perigee	=	102	50	30·85
A. Node	=	143	51	1·32
Sun's apogee	=	27	1	51·86

Solar eccentricity = 0·018331

Let A represent the epoch 0 hr. midnight G. M. T. or 5-8 A.M. Kurukṣetra time
B ,, ,, ,, 2 A.M., G.M.T. or 7-8 ,, ,,
C ,, ,, ,, 4 ,, ,, ,, 9-8 ,, ,,

Mean Sun					*Mean Moon*			
At A =	151°	57′	35″·28		At A =	145°	14′	37″·54
,, B =	152	2	30·97		,, B =	146	20	30·46
,, C =	152	7	26·66		,, C =	147	26	23·38

Moon's Perigee

At A =	102°	48′	50″·59
,, B =	102	49	24·01
,, C =	102	49	57·43

Sun's apogee = 27° 1′ 51·86

A. Node

At A =	143°	51′	48″·96
,, B =	143	51	33·08
,, C =	143	51	17·20

Sun's eccentricity (e) = 0·018331
(2e) radians = 125′·745 [2·0994901]
($\frac{5}{4}e^2$) radians = 1′·437 [0·1575563]

Longitude of Sun

	At A	At B	At C
Mean Sun	= 151° 57′ 35	152° 2′ 31″	152° 7′ 27″
Total equation	= −1 44 26	−1 44 20	−1 44 14
Apparent Sun	= 150° 13′ 9″	150° 18′ 11″	150° 23′ 13″

Longitude of Moon

	At A	At B	At C
Mean Moon	= 145 14 38	146 20 30	147 26 23
Total of six principal equations	= +3 20 30	+3 27 55	+3 35 14
Moon on orbit	= 148 35 8	149 48 25	151 1 37
A. Node (Ω)	= 143 51 49	143 51 33	143 51 17
$F_1 = M - \Omega$	= 4° 43′ 19″	5° 56′ 52″	7° 10′ 20″
$2F_1$	= 9° 26′ 38″	11 53 44	14 20 40
Reduction	= — 1′ 8″	— 1′ 26	— 1′ 43″
App. Moon	= 148° 34′ 0″	149° 46′ 59″	150° 59′ 54″

Instant of New moon = 8·3 Kurukṣetra Mean Time.

Latitude of Moon

	At A	At B	At C
$+18518{\cdot}5 \sin F_1$ =	+1518·″2	+1918·″9	+2312·″1
$+528{\cdot}3 \sin (F_1+2D-2F)$ =	−105·1	−95·5	−86·0
$-25{\cdot}0 \sin (F_1-g')$ =	−21·6	−21·9	−22·1
$+23{\cdot}8 \sin (F_1+g')$ =	−18·3	−18·0	−17·6
$+23{\cdot}2 \sin (F_1-g)$ =	−14·2	−14·1	−14·1
$-23{\cdot}6 \sin (F_1-2g)$ =	+23·2	+23·3	+23·4
$+22{\cdot}1 \sin (F_1+2D-2F-g^1)$ =	+15·2	+15·5	+15·8
Total =	+1397·4	+1808·2	+2211·5
∴ Latitude =	+23′ 17″·4	+30′ 8″·2	+36′ 51″·5

Moon's Horizontal Parallax

$$P = 3422''\!\cdot\!7 + 186\cdot6 \cos g + 34\cdot3 \cos(2D-g) + 28\cdot3 \cos 2D$$

For 'B'

$+\ 186\cdot6 \cos g$	=	$+135''\cdot3$
$+\ 34\cdot3 \cos(2D-g)$	=	$+19\cdot7$
$+\ 28\cdot3 \cos 2D$	=	$17\cdot7$
Const.	=	$3422\cdot7$
		$3605''\cdot4 = 60'\ 5''\cdot4 =$ H. Parallax.

Moon's semi-diameter $= 16'\ 22''\cdot4$
Sun's „ „ $= 17'\ 10''\cdot9$
Sun's Horizontal Parallax $= 8''\cdot9$

Calculation of the Eclipse for Kurukṣetra

(Long. $= 5^h\ 8^m$ East, and Lat. $= 30°$ N)

	A	B	C
R. A. of Mean Sun	= 151° 57′ 35″	152° 2′ 31″	152° 7′ 27″
Local mean time (from 12 noon)	= $-6^h\ 52^m$	$-4^h\ 52^m$	$-2^h\ 52^m$
Converted into degrees etc.	= −103° 0 0	−73° 0 0	−43° 0 0
R. A. of meridian or Sid. time = γQ	= 48° 57′ 35″	79° 2′ 31″	109° 7′ 27″

Obliquity of the ecliptic = 23° 58′ 24″

	A	B	C
Long. of culminating pt. of the ecliptic = γC	= 51° 30′ 2″	79° 58′ 2″	107° 24′ 49″
Decli. of cul. pt. = CQ	= 18° 32′ 28″	23° 34′ 59″	22° 47′ 20″
Angle bet. ecliptic and meridian = θ	= 74° 13′ 38″	85° 34′ 13″	π − 82° 21′ 1″
$ZC = \phi - CQ$	= 11° 27′ 32″	6° 25′ 1″	7° 12′ 43″
ZN = lat. of Zenith	= 11° 2′ 18″	6° 23′ 52″	7° 8′ 40″
CN	= 3° 5′ 43″	0° 29′ 40″	−0° 57′ 26″
$\gamma N = \gamma C + CN$	= 54° 35′ 45″	80° 27′ 42″	∴ 106° 27′ 23″

		A	B	C
Parall. in lat.	=	−11′ 28″·6	−6′ 40″·7	−7′ 27″·4
Lat. of Moon	=	+23′ 17·4	+30 8·2	+36 51·5
Corrected lat. of Moon	=	+11′ 48″·8	+23′ 27″·5	+29′ 24″·1
$\gamma\odot$ = Long. of Sun	=	150° 13′ 9″	150° 18′ 11″	150° 23′ 13″
γN = Long. of Zenith	=	54 35 45	80 27 42	106 27 23
($\gamma\odot - \gamma$N)	=	95 37 24	69 50 29	43 55 50
Parallax in Long.	=	+ 58′ 33″	+ 55′ 55″	+ 41′ 16″
Long. of Moon	=	148 34 0	149 46 59	150 59 54
Corrected long. of Moon	=	149° 32 33	150 42 54	151° 41 10
Long. of Sun	=	150 13 9	150 18 11	150 23 13
Moon − Sun	=	−0° 40′ 36″	+0° 24′ 43″	+1° 17′ 57″

Let X represent Moon − Sun, and Y represent the corrected latitude of Moon.

X =	−2436″		+1483″		+4677″
1st diff. =		+3919		+3194	
2nd diff. =			−725		

$$\therefore \quad X = +1483'' + 3556''{\cdot}5t - 362''{\cdot}5\, t^2$$

where t is measured from the instant B and is in units of two hours.

Y =	+709″		+1408″		+1764″
1st. diff. =		+699		+356	
2nd. diff. =			−343		

$$\therefore \quad Y = +1408'' + 527{\cdot}''5t - 171''{\cdot}5\, t^2$$

Sum of the semi-diameters of Sun and Moon

$$= 32'\, 33''{\cdot}3 = 1953'' \text{ nearly.}$$

Kurukṣetra mean time	X	Y	$\sqrt{X^2+Y^2}$		
5-8 A.M.	−2436″	+709″	2537″		
5-23 „	−1907	+815	2074		
				−410	
5-38 „	−1389	+916	1664		
				−322	
5-53 „	−882	+1011	1342		
				−175	
6-8 „	−386	+1101	1167		
				+ 23	+373
6-23 „	+98	+1186	1190		
				+198	
6-38 „	+571	+1265	1388		
				+303	
6-53 „	+1033	+1339	1691		
				+354	
7-8 „	+1483	+1408	2045		

Time of beginning = $5^h\ 23^m + 4^m$ = 5-27 A.M.

Time of ending = $6^h\text{-}53^m + 11^m$ = 7-4 A.M.

Duration of the eclipse = $1^h\text{-}37^m$

Time of nearest approach of centres = $6^h\ 8^m + 6^m$ = 6-14 A.M.

Minimum distance = 1154″

Magnitude of the eclipse $= \dfrac{799}{2 \times 971} = 0{\cdot}41$ = 5 Indian units.

Time of sunrise in Kurukṣetra mean time

= $5^h\ 35^m\ 20^s$ A.M. (without correcting for refraction)

= $5^h\ 32^m\ 0^s$ A.M. (corrected for refraction)

Upper limb of Sun visible at 5-30 A.M.

The eclipse began almost with sunrise.

CHAPTER XV

BRĀHMAṆA CHRONOLOGY

A Time-Reference from the Jaiminiya Brāhmaṇa

In the present chapter we propose to interpret the following astronomical reference from the *Jaiminīya Brāhmaṇa* :—

एतद्धस्म वै तत्पूर्वे ब्राह्मणा मीमांसान्ते क उस्विद् अद्य शिंशुमार्यै व्यात्तम् अतिप्रोष्यत इति। एषा ह वा एकायने शिंशुमारी प्रतीपं व्यादाय तिष्ठति यद् यज्ञायज्ञीयम्। तस्या एतद् अन्नाद्यम् एव मुखतोऽपिधाय स्वस्त्यत्येति।

J. B·āhmaṇa, I, 176.

This passage may be translated as follows :—

" This was settled by the Brāhmaṇas of former times, 'who to-day goes on a journey by passing beyond the opened (mouth) of the *Dolphin* (*i.e* , the *Dhaniṣṭhā* cluster)' ? The *Yajñāyajñīya* is this *Dolphin* which stands opening her mouth opposite (the sun) in one (*i.e.*, northerly) course. Of that it is verily the food oblation by hiding which from her mouth one passes safely."

The above translation has been done by consulting Profs. Dr. R. G. Basāk, Mm. Sītārāma Śāstrī and finally Prof. Mm. Vidhuśekhara Śāstrī, the Head of the Department of Sanskrit,

[1] *Cf.* the *Tāṇḍya Brāhmaṇa*, viii, 6, 8-9, which runs thus :—

एतद्धस्म वा आह कुशाम्बः स्वायवो ब्रह्मा लातव्यः किंस्विदद्य शिशुमारी यज्ञपथेऽप्यस्तागरिष्यति ॥८॥

एषा वै शिशुमारी यज्ञपथेऽप्यस्ता यज्ञायज्ञीयं यद्गिरागिरेत्याहात्मानं तदुद्गाता गिरति ॥९॥

Caland translates this as follows :—

8. A Brāhmaṇa, Kuśāmba the son of Svāyu, a Lātavya (by *gotra*), used to say about this chant : " Who forsooth, will today be swallowed by the dolphin that has been thrown on the sacrifice's path?"

9. Now the dolphin thrown on the sacrifice's path is the Yajñāyajñīya (*sāman*). By saying ' by hymn on hymn ' thereby the *udgātṛ* swallows himself."

Pañcaviṁśa Brāhmaṇa, viii, 6, 8-9.

It appears that this reference from the *Tāṇḍya Brāhmaṇa* is practically the same as that of the *Jaiminīya Brāhmaṇa* quoted above.

Calcutta University, Post Graduate Teaching in Arts. An English version of the German translation of the above passage by Caland is given below for comparison :

" Thus decided the Brāhmaṇas in earlier times : ' who is to *swim away* to-day against the gaping jaw of the *Dolphin?*' The *Yajñāyajñīya* is the *Dolphin* who lies in ambush at the narrow entrance with jaws opened against the current ; he puts the food in the mouth so that he can have a narrow escape as he passes by him."

We are unable to accept Caland's version. The word '*proṣyate* ' can not mean ' swim away,' neither can '*ekāyane*' mean ' the current', nor '*apidhāya* ' mean ' by putting.' The passage is allegorical which means the time for beginning the sacrifice called *Yajñāyajñīya*, was settled by the Brāhmaṇas of former times by observing the heliacal rising of the *Delphinis* cluster, with which began the sun's northerly course. The food oblation was poured into the proper fire when the day began with the sunrise and the *Delphinis* ceased to be visible. The *Delphinis* or the *Dhaniṣṭhā* cluster always rises north of the east point, while the sun at the winter solstice rises south of the same point. Hence the *Delphinis* is spoken of as ' staying opposite the sun.'

Here the word *Śiṁśumārī* has been taken to mean the *Dhaniṣṭhā* or the *Delphinis* group of stars. The word *Śiṁśumāra* literally means a dolphin. The Purāṇas interpret the word *Śiśumāra* as the star group Little Bear.[1] This meaning has been rejected for the following reasons :

We have seen before that in the Vedas, the ancient Hindus had the constellations the two Dogs,[2] *viz.*, the *Canis Major* and the *Canis Minor*, as also the heavenly boat[3] or the *Argonavis* ;

[1] *Viṣṇupurāṇa*, II, 12.

"पुच्छेऽग्निश्च महेन्द्रश्च कश्यपोऽथ ततो ध्रुवः ।
तारका शिशुमारस्य नास्तमेति चतुष्टयम् ॥"

" At the tail of the *Śiśumāra*, are the four stars, named *Agni*, *Mahendra*, *Kaśyapa* and *Dhruva* (the pole star) : these four stars of the *Śiśumāra* do not set (*i.e.*, they are circumpolar).

[2] *Ṛgveda*, X, 14, 10—11, and also *Atharva Veda*, xviii, 2, 11—12. *Loc. cit.* in the chapter on Yama and his Two Dogs.

[3] *Ṛgveda*, X, 63, 10, also *Atharva Veda*, VII, 63 and XIP, 49. 7, *Ibid*

= 270° in the year we want to find out. The year arrived at becomes 1799 B.C. or 1800 B.C. nearly as before.

In this chapter we could not use the *nakṣatra* divisions as used by Āryabhaṭa I, Brahmagupta and as given in the modern *Sūrya Siddhānta*, which was very nearly true for about 499 A.D. The history of Hindu astronomy shows that the earliest equal division of the ecliptic into 27 *nakṣatras* was made at the time of the *Vedāṅgas* and this began with the first point of the *Dhaniṣṭhā* division fixed by the luni-solar method, and we have consequently followed the same method.

Hence the traditional position of the solstices as stated in the *Maitrī Upaniṣat* was true for about 1800 B.C., but it would be rash to say that this *Upaniṣat* was composed at this date.

CHAPTER XVII

BRĀHMAṆA CHRONOLOGY

Śāṁkhāyana Brāhmaṇa

In this *Brāhmaṇa* in Chapter I, Br. 3, we have the following time-reference :—

(*a*) तदाहुः कस्मिन्नृतौ पुनरादधीतेति। वर्षास्विति हैक आहुर्वर्षासु वै सर्व्वे कामाः सर्वेषामेव कामानामाप्त्यै मध्यावर्षे पुनर्वसू नक्षत्रमुदीक्ष्य पुनरादधीत। * *। तद्वै न तस्मिन् काले पूर्वपक्षे पुनर्वसुभ्यां संपद्यते। ये वैषाऽऽषाढ्या उपरिष्टादमावास्या भवति सा पुनर्वसुभ्यां संपद्यते। उपाप्तोऽमावस्यायां कामो भवत्युपाप्तो वर्षासूपाप्तः पुनर्वस्वोस्तस्मात्तस्यां पुनरादधीत।

"People ask, 'in what season should men set up the fires again ?' One opinion is that it is the rains that are favourable for all people for attaining their desires. Hence for the realisation of all the desirable things the fires should be set up again at the middle of the year (**मध्यावर्षे**), by observing the heliacal visibility of the two stars of the *nakṣatra Punarvasu* (*viz.*, α and β *Geminorum*)."

"But at this time of observation of the heliacal visibility, there may not be the first (light) half of the month. The new-moon which comes after the full moon at the *Āṣāḍhās*, happens near the two stars of *Punarvasu* In the rains all the desirables are obtained, when the rains set in the *Punarvasus* are visible ; hence in such a new moon the fires are to be set up again."

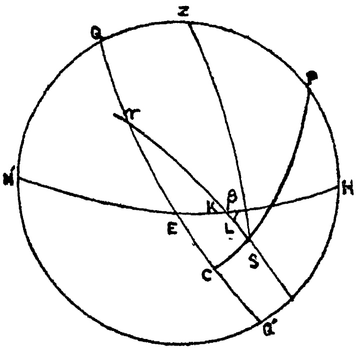
The first part of the passage implies that the middle of the year, *i.e.*, the summer solstice day was marked by the heliacal visibility of the stars α and β *Geminorum* or *Castor* and *Pollux*. The concluding portion is a makeshift arrangement, by which even the light half of the month is not obtained for setting up the fires again. We, therefore, try to ascertain the date when the first heliacal visibility of *Pollux* or β *Geminorum* took place

on the summer solstice day, the station selected being assumed as Kurukṣetra (30°N. latitude).

Heliacal Rising of Pollux on the Summer Solstice Day at Kurukṣetra

In 1941·0, Longitude of Pollux = 112° 24′ 8″
Latitude ,, ,, = + 6° 40′ 48″

Let us assume, as a first approximation, the time of the event as 1100 B.C. The obliquity of the ecliptic at the remote date was = 23° 50′ 0″ (= ω)



PS = 66° 10′ 0″. PZ = 60° ZS = 108°

∴ the angle ZPS = 130° 10′ 32″ ; ... (1)

,, .. ,, EPS = 40° 10′ 32″ ; ... (2)

∴ γE = 49° 49′ 23″. ... (3)

Now γE = 49° 49′ 23″. ω = 23° 50′ 0″ and ∠γEK = 120°,

∴ γK = 64° 58′ 2″ ; ... (4)

and LK = 46° 54′ 43″ ; ... (5)

Again LB = 6° 40′ 48″ and angle K = 46° 54′ 43″ ;

∴ KL = 6° 17′ 22″ ; ... (6)

Therefore the arc γL is found from the results (4) and (6) to have been = 71° 15′ 24″.

∴ the longitude of *Pollux* at the reqd. past date
= 71° 15′ 24″

The same in 1941 A.D. = 112° 24′ 8″

∴ the increase in celestial longitude in the intervening p riod
= 41° 8′ 44″

Hence the date arrived at is about – **1022 A.D.**

Again in the *Sāṁkhāyana Brāhmaṇa*. XIX. 2, we have :—

(*b*) तैषस्यामावास्याया एकाह उपरिष्टाद्दीक्षेरन् माघस्य वेत्याहुस्तदुभयं व्युदितं तैषस्यत्वेवोदिततरमिव त एतं त्रयोदशमधिचरं मासमाप्नुवन्ते तावान् वै संवत्सरो यदेष त्रयोदश मासस्तदत्रैव सर्वः संवत्सर आप्तो भवति ॥२॥

"They should consecrate themselves on one day after the new-moon of *Taiṣa* or of *Māgha*' they say ; both of these views are current, but that as to *Taiṣa* is the more current as it were. They obtain this thirteenth additional month ; the year is as great as this thirteenth month ; in it verily the whole year is obtained." (Keith.)

The Vedic standard month of *Māgha* came in our time in the year 1935 A.D., between Feb. 3 and March 5. Three years later *i.e.*, in 1938, after 37 lunations came the month of *Māgha* extending from January 31 to March 2. From the mode of intercalating a lunar month as found in Vedic literature, *viz.*, one month after 30 lunations, we readily recognise that the day following the new-moon of the month of *Taiṣa* or *Pouṣa* mentioned in this *Brāhmaṇa* is correctly represented in our times by the date Feb. 1, 1938. This day therefore represents in our time what was the winter solstice day in the time of the *Sāṁkhāyana Brāhmaṇa*.

Now on Feb. 1, 1938 at Calcutta Mean Noon.

the sun had the celestial longitude = 311° 44′ 19″
We deduct from it.................... ....270° 0′ 0″
Hence the difference.............................. = 41° 44′ 19″

shows the amount of the shifting of the solstices up to 1938 A.D.

The date arrived at becomes, 1056 A D., which does not differ much from the date, 1022 A.D. arrived at before.

It is further not very difficult to find a corroboration of the date arrived at, from the rule of setting up the fires again on the *Aṣāḍha* new-moon day as stated in reference (*a*) quoted before; such a new-moon happened on Aug. 3, 1940 A.D., the conjunction took place in the *nakṣatra Puṣya*, and the moon neared the star *Pollux* in the previous night at about 8 P.M., Calcutta mean time, and—

On Aug. 3, the sun's longitude was at Calcutta mean noon = 130°44′17″. This was 90° in the time of the *Sāṁkhāyana*

Brāhmaṇa showing a shifting of the solstices till 1940 A.D. =40° 44′ 17″. The date arrived at becomes,—995 A.D.

Hence the date of the *Śāṁkhāyana Brāhmaṇa* works out as about **1000 B.C.**

CHAPTER XVIII

BRĀHMAṆA CHRONOLOGY

Time Indications in the Baudhāyana Śrauta Sūtra

In the *Baudhāyana Śrauta Sūtra*,[1] the rules for beginning the year-long sacrifices are stated in the following terms :—

"ते चतुरहे पुरस्तान्माघ्यै पौर्णमास्यै दीक्षन्ते तेषामष्टकायां क्रयः सम्पद्यते इति नु यदि समामविज्ञाय दीक्षन्ते। यद्युवा एतस्यामेवैकाष्टकायां समां विजिज्ञासन्ते चतुरह एव पुरस्तात् फाल्गुन्यै वा चैत्र्यै वा पौर्णमास्यै दीक्षन्ते। तेषामपरपक्षस्याष्टम्यां क्रयः संपद्यते। तेनैकाष्टकां न छम्बट् कुर्वन्ति। तेषां पूर्वपक्षे सुत्या संपद्यते। पूर्वपक्षं-मासाभिसम्पद्यन्ते।"

Baudhāyana Śrauta Sūtra, XVI, 13.

"They consecrate themselves four days before the full-moon day of *Māgha* ; thus their purchase of *Soma* falls on the day of the last quarter (*Ekāṣṭakā*). This would be the rule if they consecrate themselves without knowing the (beginning of the) year. If, however, they want to know the (*i.e.*, beginning of the) year on the day of the last quarter of *Māgha* (*Ekāṣṭakā*, *i.e.* when the first day of the year has already been passed) they should consecrate themselves four days before, either the full-moon day of *Phālguna* or the full-moon day of *Caitra* ; their purchase of *Soma* would then fall on the 8th day of the dark half. By this they do not make the last quarter (*Ekāṣṭakā*) void. Their *Sutyā* (*i.e.* extraction of *Soma* juice) falls in the first half (*i.e.* light half) of the month, and the (sacrificial) months begin in the first (or light) half."

All this reads like a slightly modified extract from the *Taittirīya Saṁhitā* (vii, 4, 8) or from the *Tāṇḍya Brāhmaṇa* (V, 9), which has been quoted and explained in Chapter XIII, 'Solstice Days in Vedic Literature'. The author of the *Baudhāyana Śrauta Sūtra*, here recommends the following of the

[1] Edited by Caland, 1904—1913 A.D. published by the R. A. S. Bengal.

former rules by the performers of the year-long sacrifices. The rule of beginning these sacrifices four days before full-moon near the *Phalgunīs*, is the oldest that can be traced in the *Brāhmaṇas*. The alternative rule for beginning these year-long sacrifices four days before the full-moon day of *Māgha*, was true for the time of the *Taittirīya Saṁhitā* or of the *Pāṇḍavas, i.e.* for about the time when the sun reached the winter solstice on the full-moon day of the Vedic standard month of *Māgha.* Baudhāyana seems to say that on the day of the last quarter of *Māgha*, the year-beginning or the winter solstice day was already over in his time. Clearly then he does not mean the Vedic standard month of *Māgha* when giving his rule. His idea perhaps was, that the sun reached the winter solstice on the earliest possible day of the full-moon of *Māgha*, and that the winter-solstice day was inevitably over on the last quarter following it. By a full-moon day of *Māgha*, he probably means a day like the 30th of January, 1934 A.D. Now-a-days the winter solstice day is the 22nd of December. This would show a precession of the solstice-day by 39 days, and at the rate of one day of precession in 74 years, it would indicate a time of about 953 B.C. about when, the day of the last quarter of the month of *Pauṣa*, and not of *Māgha*, could be near to the winter solstice day. We shall not be wrong to assume that this *Śrauta Sūtra* speaks of a time of about 900 B.C.

This work does not say that the *Kṛttikās* (*Pleiades*) are first of the *nakṣatras*, as we find enumerated in the *Taittirīya Saṁhitā*.[1] Nor does it speak simultaneouly of the full-moon days at the *Kṛttikās* and the *Maghās*[2]—a statement which is very significant as the *Pleiades* (η *Tauri*) and the star *Regulus* (*Maghā*) have a difference in longitude of very nearly 90°. We miss here statements like that of the *Kapiṣṭhala Kaṭha Saṁhitā*, (*a*) **प्रजापतेर्वा एतच्छिरो यत् कृत्तिकाः**[3] (*b*) **पूर्णमासे वामावस्यायां यजेत**[4] or of the *Maitrāyaṇī Saṁhitā*, (*c*) **प्रजापतिर्वा आग्रयणो**[5] which mean, 'the *Kṛttikās* are

1 *Taittirīya Saṁhitā*, V, 4, 10.
2 *Mahābhārata*, *Vana*, 84, 51-52.
3 and 4 *Kap, K. Saṁhitā*, VI, 6.
5 *Maitrāyaṇī Saṁhitā*, IV, 6, 4,

the head of *Prajāpati* (year), that sacrifices are to be made on the full-moon or new-moon day and that *Prajāpati* is the day of the full-moon at the vernal equinox (*āgrayaṇa*).' All these statements mean a time about a hundred years before or after the year 2350 B.C. This *Śrauta Sūtra* has no statements of the type quoted above.

In another place (XII, 1 ; Caland's Edn.. Vol. II, page 85), Baudhāyana lays down the following rule for beginning the *Rājasūya* sacriffces:—

राजसूयेन यक्ष्यमाणो भवति स पुरस्तात् फाल्गुन्यै वां चैत्रै वा पौर्णमास्या आमा-वास्येन हविषेष्ट्वा दीक्षते ।

' When a prince is being religiously served with the *Rājasūya* sacrifice, he consecrates himself by making oblations of clarified butter, on the new-moon day which precedes the full-moon day either of *Phālguna* or of *Caitra*.'

It is difficult to see what season of the year is taken to begin on the new-moon which precedes the full-moon either of *Phālguna* or of *Caitra*. The former of these new-moons simply means the new moon of *Māgha*, which is but a repetition of an older tradition of the winter-solstice day as stated in the *Kauṣītaki Brāhmaṇa* [1] (XIX, 3). The *Mahābhārata* indicates, according to our interpretation, that Yudhiṣṭhira was consecrated for the *Aśvamedha* sacrifice on the full-moon day of *Caitra* of the year 2446 B.C. The Vedic standard month of *Māgha* as it came that year was similar to that of our time in 1932 A.D., and the full-moon day of *Caitra* of 2446 B.C. corresponded with the full-moon day of April 20, 1932 A.D. The new-moon day which preceded this full-moon happened on the 6th April, 1932 A.D. If the *Baudhāyana* rule indicates that spring began according to this recorded tradition, the date when this was true, would become about 1400 B.C. If Baudhāyana, means a year like 1927 A.D. on which the new-moon in question happened on April 2, the date would come out to have been about 1100 B.C. If again it was a new-moon of the type of March 30, 1930 A.D. the date of the tradition would be about 886 B.C. In any case

[1] JRASBL, Vol. IV, 1938; page 422.

we do not get any clear indication of time from this reference. We shall, however, later on find the day for starting the *Rājasūya* sacrifice in the year 886 B.C. A more definite indication of the date of this *Śrauta Sūtra* is furnished by the :—

Baudhāyana Rule for Nakṣatreṣṭi Sacrifices

The part of the work where it gives the time for beginning the *Nakṣatreṣṭi* sacrifices,[1] runs as follows :—

अथातो नक्षत्रेष्टीर्व्याख्यास्यामोऽग्निर्वा अकामयतान्नादो देवानां स्यामिति ता ब्राह्मणेन व्याख्याताः । साया वैशाख्याः पौर्णमास्याः पुरस्तादमावास्या भवति स सकृत्-संवत्सरस्यापभरणीभिः संपद्यते तस्यामारभेतेति ।

"We now proceed to explain the rule for performing the *Nakṣatreṣṭi* sacrifices. Agni wished, 'I would be the partaker of food for the gods.' This has been set forth by the *Brāhmaṇa* (*T. Br.* iii, 1, 4, *et. seq.* as found by Caland). The full-moon which occurs near the *Viśākhās* has its preceding new-moon once in the year in the *Bharaṇī* division; this new-moon is the day for starting the *Nakṣatreṣṭi* sacrifics."

A little later the rules run as follows :—

विशेषान् व्याख्यास्यामः । प्रजापतिः सवितेत्यपांशुः सर्पेभ्य आश्रेषाभ्य आज्ये करम्भमिति सर्वे यवा भवन्ति ।

"We shall now explain the special rules : Prajāpati the sun becomes *Upāṁśu* (of subdued light due to the starting of the rains) on getting at the *Āśleṣā* division. Hence all barley corns become *Karambha* (barley powder mixed with curd) which are to be mixed with clarified butter for oblation."

Here evidently the sun is said to reach the vernal equinox on the new-moon which preceded the full-moon in the *Viśākhā* division or near the *Viśākhā* 'junction' stars. Such a new-moon was of rare occurrence. Also the sun seemed to turn south at the beginning of the division *Āśleṣā*, and not at its middle. True it is that this *Śrauta Sūtra* says[2] :—

माघमासे धनिष्ठाभिरुत्तरेणैति भानुमान् ।
अर्धाश्लेषस्य श्रावणस्य दक्षिणेनोपनिवर्तते ॥ इति काष्ठे भवतः ।

1 *Baudhāyana Śrauta Sūtra* XXVIII, 2-4.
2 *Ibid.*, XXVI, 29.

"In the month of *Māgha* the sun on getting at the *Nakṣatra* division *Dhaniṣṭhā*, turns to the north and at the middle of the *Aśleṣā* division turns to the south in the month of *Śrāvaṇa*. These are the two limits to the sun's north-south motion."

This is evidently borrowed from the *Vedāṅgas*. This position of the solstices was not true for the time of the *Baudhāyana Śrauta Sūtra*.

We understand that at the time indicated by *Nakṣatreṣṭi* rules of *Baudhāyana*, the summer solstice was at the beginning of the *Aśleṣā* division, that the vernal equinox was consequently at the end of the first quarter of the *Bharaṇī* division, and the winter solstice was at the middle of the *Śravaṇā* division.

Now the oldest division of the ecliptic began with the ecliptic position of *β-Delphinis* as the first point of the *Dhaniṣṭhā* division.

The longitude of *β-Delphinis* in 1935 A.D.	= 315° 26′ 5″
Deduct half *nakṣatra*	− 6 40 0
∴ the longitude of the middle of *Śravaṇā* divn.	= 308° 46′ 5″
Again deduct	270 0 0
Hence the long. of the end of the 1st quarter of *Bharaṇī* division	= 38° 46′ 5″

Now the longitude of the sun at Calcutta Mean noon on April 20, 1938 A.D., a new-moon day, was = 39° 14′ 34″.

This fairly agrees with the longitude of the last point of the 1st quarter of the *Bharaṇī* division obtained above.

Here a shifting of the equinoxes till 1931 A.D. of 39° 14′ 34″ indicates a lapse of 1828 years and the date arrived at becomes 891 B.C. If we want to get at a year near to this date and similar to 1938 A.D., that year becomes 886 B.C. or −885 A.D.

This date appears to be the time indicated by the *Nakṣatreṣṭi* rule of the *Baudhāyana Śrauta Sūtra*.

The Baudhāyana rule for the *Pañcaśāradīya* Sacrifices

In another place the *Baudhāyana Śrauta Sūtra* lays down the following rule for beginning the *Pañcaśāradīya sacrifices*. These lasted for 5 years and were begun with the advent of the Indian

season of *Hemanta* or of the dews and ended with the Indian season of *Śarat* or autumn. Hence on the day for the beginning of this *Pañcaśāradīya* sacrifices, the desired celestial longitude of the sun was about 210°. The *Baudhāyana* rule runs as follows:—

पञ्चशारदीयेन यक्ष्यमाणो भवति स उपकल्पयते सप्तदश निरष्टान् वत्सतरान् एकहायनान् स पुरस्तान् मार्गशीर्ष्यै पौर्णमास्या आमावास्येन हविषेष्ट्वा सप्तदशमारुतीः पृश्नीर्वत्सतरीरालभते। * * *

B. S. Sūtra, XVIII, 11

" When a person is being served by the five-yearly sacrifice, he selects seventeen he-calves which are more than 8 days old and of not exceeding one year in age. He makes the sacrifice with oblations of clarified butter on the new-moon which precedes the full-moon at the star group *Mṛgaśiras* [1] (*i.e.*, λ, ϕ_1, and ϕ_2, *Orionis*) and secures seventeen she-calves of which the presiding deities are the *Maruts* or wind gods."

The practice was to release 17 he-calves and 17 she-calves for freely roaming about in the fields or forests in the 1st year, 17 she-calves in the 2nd year, 17 she-calves in the 3rd year, and 17 she-calves in the fourth year were also set at liberty. It is not clear if in the fifth year also the same practice was continued. The day for beginning the sacrifice was of the new-moon preceding the full-moon at the *Mṛgaśiras* (*i.e.*, λ, ϕ_1, ϕ_2 *Orionis*) group.

Now in the year 1929 A.D., the full-moon near λ *Orionis* fell on December 16 ; and the preceding new-moon happened on December 1. We assume here that the sun's longitude increased by 60° in two lunations very nearly. Hence the sun reached the winter solstice on the day which correspond with the new-moon on the 29th January, 1930 A.D.

On this day, *i.e.*, January, 29, 1930, at 6 M.N. the sun's apparent longitude was ... ... $= 308^\circ\ 53'\ 1''$

Deduct ... ... $270^\circ\ 0'\ 0''$,

[1] *Cf. Āpastamba Gṛhya Sūtra*, XIX, 9-3-2, which records a tradition of the beginning of *Hemanta* on the *Mṛgaśiras* full-moon day which corresponds to a mean date of about 2000 B.C.

new-moons answering to the above description happened in the year 884 B.C., as the following calculation will show :—

Year and date	Julian days	At G. M. Noon		Remarks.
		Appt. Sun	Appt. Moon	
—888 A.D. April, 19	1398651	19° 41′	194° 27′	F. M. in *Viśākhā* Dn.
—883 A.D. May, 4	1398666	34° 1′	23° 48′	N. M. in *Bharaṇī* Dn. for setting up fires.
—883 A.D. June, 3	1398696	62° 34′	58° 45′	N. M. in *Punarvasu* Dn. for setting up fires.
—883 A.D. June, 27	1398710	75° 54	253° 0′	F. M. in *U. Āṣāḍhā* Dn.

Viśākhā division = 182° 59′ to 196°19′
Punarvasu division = 62° 59′ to 76° 19′
Long. of *Pollux* = 73° 14′

It is evident that such new-moons came in also in the year 895 B.C., *i.e.* 8 years before the date 887 B.C. arrived at before. The *Śatapatha Brāhmaṇa*[1] lays down the rule that fires should be set up, on the day of the new-moon with which the lunar *Vaiśākha* ended, meaning of course the new-moon, either at the *Kṛttikās* or the *Hyades* (*Rohiṇīs*). These rules for setting up fires by a householder have nothing to do with the beginning of any season of the year and do not indicate the date of the *Baudhāyana Sūtra*, nor of the *Śatapatha Brāhmaṇa*, nor of any other work of the kind.

We are thus led to conclude that the mean date for the Baudhāyana rules for sacrifices should be taken as the year 887-16 B.C.

[1] *Śatapatha Brāhmaṇa*, XI, 1. 1. 7 ; cited by S. B. Dīkṣita in his भारतीय ज्योतिःशास्त्र, page 130 (1st Edn.) योऽसौ वैशाखस्यामावस्या तस्यामादधीत......आत्मन्येव तत् प्रजायां पशुषु प्रतितिष्ठति ॥

Again in this year,—886 A.D.,

the longitude of the end of the 1st qr. of *Bharaṇī* = 359° 39′
,, ,, ,, 1st pt. of the *Viśākhā* division = 182° 59′
,, ,, ,, ,, *Mṛgaśiras* ,, = 36° 19′
,, ,, ,, mid-point of the *Śravaṇā* ,, = 269° 39′

Thus the year 887-86 B.C. appears to be the mean date indicated by the *Baudhayana* rules for beginning the *Nakṣatreṣti*, the *Pañcaśāradīya* and the *Rājasūya* sacrifices. This date however, is liable to being lowered by 76 years or by even a greater luni-solar period.

We now take up the *Baudhāyana* rules for setting up fires by the householder. The rules in question state the suitable or auspicious days for the purpose and have nothing to do with the beginnings of the seasons. The auspicious days are the new-moon days at (1) *Kṛttikās*, (2) *Rohiṇīs*, (3) *Punarvasus*, (4) *P. Phalgunīs*, (5) *U. Phalgunīs* and (6) *Citra*. A Brahmin is to set up his fires in spring, a Kṣatriya in summer, a Vaiśya in autumn and a car-maker in the rains.[1] In this connection it is said :—

(*a*) "या वैशाख्याः पौर्णमास्या उपरिष्टादामावास्या भवति सा सकृत् संवत्सरस्य रोहिण्या सम्पद्यते तस्यामादधीत ।

' The new-moon which follows the full-moon in the *Viśākhā* division, once happens in a year with the moon in the *Rohiṇī* division, that is the day on which the fires are to be set up.'

This rule states when to get at the day of a new-moon in the *Rohiṇi Nakṣatra*. There is another rule given for settling when to get at a new-moon near the *Punarvasus* (*Castor* and *Pollux*).

(*b*) या आषाढ्याः पौर्णमास्याः पुरस्तादमावास्या भवति सा सकृत् संवत्सरस्य पुनर्वसुभ्यां संपद्यते तस्यामादधीतेति[2] ।

' The new-moon which precedes the full-moon in the *Nakṣatra Āṣāḍhā* (here the *U. Āṣāḍhā*), once (*i.e.*, on rare occasions) happens in a year with the moon near the *Punarvasu* (*Castor* and *Pollux*) ; the fires should be set up on this day."

These are purely luni-solar-stellar phenomena which repeat roughly in 8, 11 or 19 years. The *Rohiṇī* and the *Punarvasu*

[1] Baudhāyana S. Sūtra, II, 12.

[2] *Ibid*, III, 1, : this is also repeated in XXV, 18.

new-moons answering to the above description happened in the year 884 B.C., as the following calculation will show:—

Year and date	Julian days	At G. M. Noon		Remarks.
		Appt. Sun	Appt. Moon	
—883 A.D. April, 19	1398651	19° 41′	194° 27′	F. M. in *Viśākhā* Dn.
—883 A.D. May, 4	1398666	34° 1′	23° 48′	N. M. in *Bharaṇī* Dn. for setting up fires.
—883 A.D. June, 3	1398696	62° 34′	58° 45′	N. M. in *Punarvasu* Dn. for setting up fires.
—883 A.D. June, 27	1398710	75° 54′	253° 0′	F. M. in *U. Āṣāḍhā* Dn.

Viśākhā division = 182° 59′ to 196°19′
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Long. of *Pollux* = 73° 14′

It is evident that such new-moons came in also in the year 895 B.C., *i.e.* 8 years before the date 887 B.C. arrived at before. The *Śatapatha Brāhmaṇa*[1] lays down the rule that fires should be set up, on the day of the new-moon with which the lunar *Vaiśākha* ended, meaning of course the new-moon, either at the *Kṛttikās* or the *Hyades* (*Rohiṇīs*). These rules for setting up fires by a householder have nothing to do with the beginning of any season of the year and do not indicate the date of the *Baudhāyana Sūtra*, nor of the *Śatapatha Brāhmaṇa*, nor of any other work of the kind.

We are thus led to conclude that the mean date for the Baudhāyana rules for sacrifices should be taken as the year 887-16 B.C.

[1] *Śatapatha Brāhmaṇa*, XI, 1. 1. 7 ; cited by S. B. Dīkṣita in his भारतीय-ज्योतिःशास्त्र, page 130 (1st Edn.) योऽसौ वैशाखस्यामावस्या तस्यामादधीत......आत्मन्येवैतत् प्रजायां पशुषु प्रतितिष्ठति ॥

One point more that we want to notice here is that the *Baudhāyana Śrauta Sūtra* mentions the name Pāṇini in the *Pravara* section 3 (Vol. III, p. 418) and also the name Kaulāśva Yāska in XVI, 27. Whether these statements place the dates of the celebrated grammarian and the author of the Vedic lexicon, *Nirukta*, before the time of the *Baudhāyana Śrauta Sūtra* (900.B.C. nearly), is a matter that cannot be settled astronomically. True it is that the word '*Yavanānī*' as found in Pāṇini means the written alphabet of the Ionian Greeks, but it would be far from rational to conclude that the Yavanas did not come to India before the times of Alexander or of Darius.

CHAPTER XIX

BRĀHMAṆA CHRONOLOGY

The Śatapatha and the Taittirīya Brāhmaṇas

The time when the *Śatapatha Brāhmaṇa* came into its present form is indicated by the following passage[1] :—

तदाहुः । कस्मिन्नृतावभ्यारम्भ इति ग्रीष्मेऽभ्यारभेतेत्युहैकऽआहुर्ग्रीष्मो वै क्षत्रियस्यऽर्तुः क्षत्रिययज्ञ उवाऽएष यदश्वमेध इति ॥२॥ तद्वै वसन्तऽ एवाभ्यारभेत । वसन्तो वै ब्राह्मणस्यऽर्तुर्यो उ वै कश्च यजते ब्राह्मणीभूयेवैव यजते तस्माद्वसन्तऽ एवाभ्यारभेत ॥३॥ सा यासौ फाल्गुनी पौर्णमासी भवति । तस्यै पुरस्तात् षड्हे वा सप्ताहे वऽर्त्विज उपसमायान्त्यध्वर्युश्च होता च ब्रह्मा चोद्गाता चैतान् वाऽ अन्वन्यऽ ऋत्विजः ॥४॥

"In this connection they say 'in what season is the beginning to be made?' Some say 'it should be begun in summer, as summer is the season for the Kṣatriyas and the *Aśvamedha* is the sacrifice for the Kṣatriyas alone. This should be begun in spring alone, as spring is the season for the Brāhmaṇas; *whoever makes the sacrifice begins it by being a Brāhmaṇa as it were.* Hence this sacrifice is to be begun with the spring alone. That beginning takes place on the full-moon night at the *Phalgus.* Six or seven days before it, come the priests who are *adhvaryu, hotṛ, brahmā, udgātṛ,* etc."

In this passage we get the indication that the Indian spring at this period, set in at the full-moon near the *Phalgus* or that the sun had the tropical longitude of 330° on the full-moon day of *Phālguna.* In the earliest Vedic times the full-moon day of *Phālguna* was the winter solstice day, and the time was about 4600 B.C. Here we notice a clear statement that the full-moon day of *Phālguna* was the beginning of spring. The date, which is at the end of this transitional age, has been shown in the next chapter as about 625 B.C. Although this *Brāhmaṇa* records

[1] *Śatapatha Brāhmaṇa*, 13, 4, 1, 2 to 4. Weber's Edn., page, 979.

the traditions about Yājñavalkya and Janaka of Mithilā, the present recension of it cannot be much earlier than what has been stated above. This change in the meaning of the *Phālgunī* full-moon is also recorded by the *Āpastamba* and *Kātyāyana Śrauta Sūtras*.

In the *Taittirīya Brāhmaṇa* also we have evidence of this new meaning of the *Phālgunī* full-moon day[1] :—

वसन्ता ब्राह्मणोऽग्निमादधीत। वसन्तो वै ब्राह्मणस्यर्तुः। स्व एवैनमृतावाधाय। ब्रह्मवर्चसी भवति। मुखं वा एतदृतूनां यद्वसन्तः। यो वसन्तेऽग्निमाधत्ते। मुख्य एव भवति। * * * *

ग्रीष्मो वै राजन्यस्यर्तुः। शरदि वैश्य आदधीत। शरद्वै वैश्यस्यर्तुः ॥७॥

न पूर्वयोः फल्गुन्योरग्निमादधीत। एषा वै जघन्या रात्रिः संवत्सरस्य यत्पूर्वे फल्गुनी। पृष्ठित एव संवत्सरस्याग्निमाधाय। पापीयान् भवति। उत्तरयोरादधीत। एषा वै प्रथमा रात्रिः संवत्सरस्य। यदुत्तरे फल्गुनी। मुखत एव संवत्सराग्निमाधाय। वसीयान् भवति इति ॥८॥

"A Brāhmaṇa should set up his fire in spring. Spring is the season for the Brāhmaṇa......what is spring is the first season of the year. One who sets up fire in spring, becomes a chief among men... .... Summer is the season for the Rājanya (Kṣatriya). A Vaiśya should set up his fire in autumn and autumn is the season for the Vaiśyas.

"Fire should not be set up on the day of full-moon at the *Pūrva Phālgunīs* (δ and θ *Leonis*). It is the last night of the year what is the full-moon at the *Pūrva Phālgunīs* ; a man becomes a sinner by making fire for the year at the fag end. Fire should be set up in the full-moon at the *Uttara Phālgunīs* (β *Leonis* and another small star near to it); it is the first night of the year—the full-moon night at the two *Uttara Phālgunīs*. A man becomes wealthy by making fire from the very beginning (of the year)."

Thus in the *Taittirīya Brāhmaṇa* also we have a clear indication of this new meaning of the *Phālgunī* full-moon. The date for this meaning cannot be much earlier than about 625 B.C. as is set forth in the next chapter.

1 *Taittirīya Brāhmaṇa*, 1, 8, 2, 7-8.

The question whether the superior limit to the date when the full-moon at the *Uttara Phālgunīs* marked beginning of spring can be raised higher than this 625 B.C., is a very knotty one. If it can be established that at the time of these *Brāhmaṇas*, the calendar makers could discover the occurrence of the second *Phālguna* as an intercalary month, the date may go up to 757 B C. as the following calculations will show :—

On Feb. 27, T 756 A D., at G.M.—0 hr. or K.M.T., 5-8 A.M. we have,

Apparent sun = 330° 0′ 8″.

,, Moon = 148° 10′ nearly,

and *β Leonis* = 133° 21′

The full-moon happened 4 hours later, not very far from *β Leonis*, the 'junction' star of the *nakṣatra*, *Uttara Phālgunī*. This full-moon was similar to that which happened on March 28, 1945 A.D.

Again as the *Śatapatha Brāhmaṇa* has very frequent references to *Aṣāḍhā*[1] (अषाढ़ा), which means the full-moon at the *nakṣatra*, *Uttarāṣāḍha*, we understand that the full-moon at this *nakṣatra* in some years marked the summer solstice day. Now we had on July 1, 762 A.D. a full-moon as :—

On June, 30,—762 A.D , at G.M. Noon.

Appt. Sun = 89° 7′ 54″,

,, Moon = 265° 5′ 44″ nearly

Śravaṇā or *Altair* = 263° 25′ 41″

The full-moon happened about 12 hrs. later, *i.e.*, at about 5-8 A M. of Kurukṣetra mean time of July, 1, and this was also summer solstice day. This full-moon was similar to that which happened on July, 31, 1939 A.D. The *Śatapatha Brāhmaṇa* indicates that the *āṣāḍhī* or the full-moon at the *nakṣatra* *āṣāḍha* was in some years the summer solstice day and in some

[1] Cf. *Śatapatha Brāhmaṇa*, 2 ch., 6, 3, 12-13; 8ch., 5, 4, 1; the last reference has अषाढ़ा वै रस एष वाचि which is most significant. Cf. also 11 ch. 4, 2, 5 and c.

years the full-moon at the *Uttara Phālguni* marked the coming of spring. These two phenomena, of course cannot happen in the same year.

If the rule-givers or calendar-makers could discover the second *Caitra* as an intercalary month, the date may go up to 901 B.C. for the *Phalguni* full-moon marking the advent of spring. We had on Feb. 28,—900 A.D., G. M. Noon

Appt. Sun = 330° 24′ 56″

,, Moon = 144° 59′ 50″

β Leonis = 131° 22′ 48″.

This full-moon corresponds to that on 31st March, 1934 in respect of the moon's phases near to the fixed stars.

The corresponding *āṣāḍhi* fell on the 2nd of July, 906 A.D. on which at G. M. N.,

Appt. Sun = 89° 49′ 22″

,, Moon = 269° 3′ 33″

and *Altair* or *Śravaṇā* = 261° 27′ 29″

The full-moon happened in about 1½ hrs. It was similar to the full-moon on August 1, 1921 A.D.

It must be said on the other hand that the *Vedāṅga* calendar recognises only the second *Āṣāḍha* and the second *Pauṣa* as intercalary months. On this basis, the date cannot be raised beyond 625 B.C.

CHAPTER XX

BRĀHMAṆA CHRONOLOGY

Time References from the Kātyāyana and the Āpastamba Śrauta Sūtras

In this chapter we propose to interpret as far as possible the following time references first from the *Kātyāyana Śrauta Sūtra* and shall also consider those from the *Āpastamba Śrauta Sūtra*. Those from the first work are :

(*a*) शुक्लपक्षसप्तम्यां दीक्षा सरस्वती-विनशने ।

Pt. I, XIV, 5, 30.

" The day for being consecrated for the *Sārasvata* sacrifice is the seventh day of the light half (of *Caitra*)."

(*b*) तुरायणं वैशाखीशुक्लस्य पञ्चम्यां ॥१॥ चैत्रस्य वा ॥

Pt. II, II, 1.2.

" The *Turāyaṇa* sacrifice is to be made on the 5th day (*tithi* ?) of the light half of *Vaiśākha* or of *Caitra*."

(*c*) द्वितीयः पञ्चशारदीयः ॥३॥ तेन यक्ष्यमाणः पञ्चवर्षाण्याश्वयुजीशुक्लेषु चतुस्त्रिंशतं पशूनालभते मारुतान् वैश्वस्तोमान् क्षिणादङ्गान् ॥४॥

Pt. II, XXII, 4, 34.

" The second is the five-yearly or the *Pañcaśāradiya* sacrifice. One who is being served by this sacrifice collects in the light half of the month of *Āśvina*, thirty-four animals (*i.e.*, 17 bull-calves and 17 cow-calves) which are sacred to the Maruts to be liberated in honour of the Vaiśvadevas with the proper sacrificial fees to the priests."

(*d*) चातुर्म्मास्यप्रयोगः फाल्गुन्याम् ॥१॥

Pt. I, V, 1, 1.

" The four monthly sacrifices to be begun on the full-moon day of *Phālguna*."

(*e*) आषाढ्या "मयन्तेयोनि"रिति समारोह्यादवसाय निर्मथ्य वरुणप्रघासाः ॥

1 . 1.

" The *Varuṇapraghāsa* ceremony is to be performed on the full-moon day of *Āṣāḍha*......... "

(*f*) "संवत्सरेप्सोः फाल्गुन्युद्दृष्टे शुनाशीरीयेणेष्ट्वा सोमेन पशुनेष्ट्वा वा यजेत पौर्णमास्याम् ।"

" The sacrificer who wants a year-long sacrifice should begin by performing the *Sunāśīriya* sacrifice with Soma or an animal on the day of the first visibility of the crescent before the full-moon day of *Phālguna* ; the sacrifices to continue from the full-moon day "

(*g*) "राज्ञोऽश्वमेधः सर्व्वकामस्य ॥१॥ अष्टम्यां नवम्यां वा फाल्गुनीशुक्लस्य ॥२॥

Pt. II, xx, 1. 1–2

The king who wants all his desires to be satisfied should perform the *Áśvamedha* sacrifice: he should get consecrated for it on the eighth or the ninth day or *tithi* of the light half of *Phālguna*."

(*h*) माघीपक्षयजनीये दीक्षा ।

Pt, II, xv, 1, 4.

" A king should consecrate himself for the *Rājasūya* sacrifice in the light half of *Māgha*."

(*i*) वाजपेयः शरदि अवैश्यस्य ॥१॥

Pt. II, xiv. 1, 1

" The *Vājapeya* sacrifice is to be done in autumn by people other than Vaiśyas, *i.e.*, by the Brāhmaṇas and the Kṣatriyas."

Of the 9 references quoted above the most striking are the references (*d*) and (*e*) which tend to show that the full-moon day of *Phālguna* was regarded as the beginning of spring and that the full-moon of *Āṣāḍha* was taken as the summer solstice day or the advent of the rains according to the nature of different years of the time. It is evident that both such full-moon days as indicative of the starting of spring and of the rains, cannot be comprised in the same year as four lunations

= 118 nearly and the two seasons roughly = 122 days. This latter period is affected by the position of the sun's apse line.

Originally in the earlier Vedic period the full-moon day of *Phālguna* meant the winter solstice day, when the new-moon of *Māgha* ended, also meant the same day of the tropical year. These phenomena came at intervals of four years as 4 tropical years = 1461 days nearly and 49·5 lunations = 1460 days approximately and the moon's perigee playing an important part may contribute to the equality of the two periods.

Now coming down to the time of the *Kātyāyana Śrauta Sūtra*, the same day is spoken of or indicated as the beginning of spring. We are thus led to a period when the full-moon day of *Phālguna* came to be interpreted differently. We accordingly take the full-moon day of *Phālguna* of the *Kātyāyana Śrauta Sūtra* to be a day like the 26th of March, 1937, the latest possible day in our time for this lunar phase according to the *Vedāṅga* calendar, which was taken for the beginning of spring at the time of this *Śrauta Sūtra*.

Now on March 26, 1937 at G. M. N., the sun's apparent longitude was = 5° 26′ nearly, and this longitude at the time of this *Śrauta Sūtra* was according to our interpretation = 330°. Hence the shifting of the solstices was 35° 26′ up to 1937 A.D.

This indicates a lapse of 2560 years till 1937 A.D. and the date as,—**623 A.D.**

Similarly using the latest possible day for the *Āṣāḍha* full-moon day according to the *Vedāṅga* calendar in our time was the 29th July, 1931. On this day at G.M.N., the Sun's longitude was = 125° 23′ nearly. As this longitude at the time of this *Śrauta Sūtra* was = 90° for the summer solstice day, we see that the shifting of the solstices till 1931 becomes 35°23′ nearly, indicating a lapse of 2560 years and the date as,—629 A.D.

Thirdly by considering the reference (*b*) as to the *Turāyaṇa* sacrifice day, we take the day in question as similar to April 25, 1936 A.D. which was the vernal equinox day of a year at the time of the *Śrauta Sūtra*.

Now on April 25, 1936 A.D. the sun's apparent longitude was=35°1′, which represents shifting of the solstices, and the year arrived at becomes,—624 A.D.

Fourthly it is possible to arrive at the date,—624 A.D from reference (c) from the *Pañcaśāradīya* sacrifices. The day in question appears to have been the *Anumati* full-moon day of *Āśvina*.

The reference (f) is an echo from the *Śatapatha Brāhmaṇa*, and this *Śrauta Sūtra* is a crude follower of an old rule. The rest of the references do not present any peculiarly interesting feature.

A calendar for,—624 to—623 A.D. and for one day of,—629 A.D. are shown below, giving the sacrificially important dates:

Luni-solar Elements at G. M. N.

Julian Calendar	Julian Days	Appt. Sun	Appt. Moon	Remarks
−629 A.D. Jan. 30	1491416	89°50′8″	269°32′	Summer Solstice day on *Āṣāḍha* F. M. day. *Varuṇa Praghāsa* to start
−624 A.D. Mar. 27	1493228	359°48′3″	54°4′	Lunar *Vaiśākha*, 5th day of light half. V. Equinox day. *Turāyaṇa* sacrifice day.
−624 A.D. April, 6	1493238	9°27′16″	181°58′	F. M. near α *Libra* (*Viśākhā*)
−624 A.D. Sept. 29	1493414	179°40′23″	353″23′	*Anumati* F. M. day on Autumnal Equinox day. *Pāñcaśāradīya* to start.
−623 A.D. Feb. 25	1493563	330°17′1″	144°34′	F. M., in *U. Phālgunī* spring begins *Cāturmāsya* to start.

Precession of Equinoxes from —624 to 499 A.D. = 15°32′28″.

The *Dhaniṣṭhā nakṣatra* extends from 277°47′32″ to 291°7′3″

Aśvinī ,, ,, ,, ,, 344°27′32″ to 357°47′32″

Uttara Phalgunī ,, ,, 131°7′32″ to 144°27′20″

Uttara Āṣāḍhā ,, ,, 251°7′32″to 264°27′32″

Viśākhā ,, ,, ,, 184°27′32″ to 197°47′32″

We are thus led to conclude that the *Kātyāyana Śrauta Sūtra* should be dated about the period from,—629 to —623 A.D. The date of the rules for the various sacrifices can not be raised, but it may be lowered, if necessary, (for the book) on literary and other evidences.

We give the translation by Mrs. Rhys Davids[1]:—

"The Exalted One was once staying at Sāvatthī. Now at that time Chandimā, son of the Devas, was seized by Rāhu, lord of Asuras. Then Chandimā, calling the Exalted One to mind, invoked him by this verse:—

O Buddha! Hero! glory be to thee!
Thou art wholly set at liberty!
Lo! I am fallen into dire distress!
Be thou my refuge and my hiding place!

Then the Exalted one addressed a verse to Rāhu, lord of the Asuras, on behalf of Chandimā, son of the Devas:—

To the Tathāgata, the Arahant
Hath Chandimā for help and refuge gone.
O Rāhu, set the moon at liberty!
The Buddhas take compassion on the world."

We next cite the section or sutta:

§ 10. *Suriyo.*

1. Tena kho pana Samayena Suriyo devaputto Rāhunā asurindena gahito hoti|| Atha Kho Suriyo devaputto Bhagavantam anussaramano tāyam velāyām imam gāthām abhāsi || ||

2. Namo te Buddha Vīra-tthu || Vippamuttosi sabbadhi || Sambādhapatippanno-smi || tassa me saraṇaṁ bhavāti || ||

3. Atha Kho Bhagavā Suriyam devaputtaṁ ārabbha
Rāhum asurindam gāthayā ajjhabhāsi || ||
Tathāgatam arahantam || Suriyo saraṇaṁ gato ||
Rāhu pamuñca Surīyam || buddhā lokānukampakāti || ||
Yo andhakāre tamasi pabhaṁkaro ||
Verocano maṇḍalī uggatejo ||
Mā Rāhu gilīcaram antalikkhe ||
Pajaṁ mama Rāhu pamuñca Sūriyan-ti || ||

Mrs. Rhys Davids' translation runs as follows:—

"Now at that time, Suriya, son of Devas, was seized by Rāhu, lord of Asuras. Suriya, calling the Exalted One to mind, invoked him by this verse:—

O Buddha! Hero! Glory be to thee!
Thou art wholly set at liberty!

[1] The Book of the Kindred Sayings (*Saṁyutta-Nikāya*), pages 71-73

Lo! I am fallen into sore distress.
Be thou my refuge and my hiding-place!

Then the Exalted One addressed a verse to Rāhu, lord of Asuras, on behalf of Suriya, son of the Devas:—

To the Tathāgata, the Arahant,
Hath Suriya for help and refuge gone.
O Rāhu, set the sun at liberty!
The Buddhas take compassion on the world.
Nay, Rāhu, thou that walkest in the sky,
Him that thou chokest, darkening the world.
Swallow him not, the craftsman of the light,
The shining being of the disc, the fiery heat,
My kith and kin—Rahu, set free the sun!"

We understand that the eclipse of the moon was closely followed by an eclipse of the sun, and apparently at a very short interval, *viz.*, of a fortnight, as the phrase *tena kho pana samayena* (तेन खलु पुनः समयेन) indicates, *i.e.*, the two events happened in the short period of time of the Buddha's stay at Śrāvastī.

Now the mere happening of two eclipses, one of the moon followed only a fortnight later by one of the sun, is not quite adequate for settling our problem. We want one more circumstance of the eclipses, *viz.*, the lunar month in which these two eclipses were visible at Śrāvastī. The *Devaputta Samyuttam* contains ten *suttas* in all, of which two relate to *Kassapa*, one each to *Māgha*, *Māgadha*, *Dāmani*, *Kāmada*, *Pañcālcanda*, *Tāyana*, *Candimā* and *Surio*. All of these are spoken of as sons of *Devas*.

Now the *Devas* according to the Hindu tradition are 33 in number.[1] They are the eight *Vasus*, eleven *Rudras*, twelve *Ādityas*, *Indra* and *Prajāpati*.

Here *Kassapa Devaputta* may be identified with *Prajāpati* the presiding deity of the five-yearly luni-solar Vedic cycle. The twelve *Ādityas* are the twelve months of the year and consequently the lunar month of *Māgha* is a *Deva* according to the Hindu tradition. It is therefore likely that lunar *Māgha* itself

1 *Bṛhadāraṇyaka Upaniṣat*, Chap. III, Br. 9, 2-3.

is spoken of here as *Māgha Devaputta* in the *Saṁyukta Nikāya*. In the *Devaputta sutta* it is said that first came *Kassapa* to meet the Buddha, then came *Māgha* and then came the rest. So far as we can understand of the allegory underlying these *suttas*, the winter solstice day marking the advent of *Kassapa* or *Prajāpati* came first, then came the full-moon ending month of *Māgha*, a *Devaputta* with the full-moon near the *nakṣatra Puṣyā*. The *Devaputtas* of the section are probably some other gods either of the Hindu or of the Buddhist tradition.

The two consecutive eclipses spoken of in the *Samyukta Nikāya* most probably happened in the following order:

(1) *Kassapa* or the winter solstice day came first.

(2) An eclipse of moon followed it at about the 'junction star' δ-Cancræ.[1]

(3) An eclipse of the sun came a fortnight later.

Thus the solar eclipse happened in the middle of the full-moon ending *Māgha* and the lunar eclipse at its beginning; both the astronomical events were observable from Śrāvastī where the Buddha was staying at the time.

Now on looking up the work *Canon der Finsternisse*,[2] we find that in the period of time from —580 A.D. to —483 A.D., the only eclipses first of the moon and then of the sun at an interval of a fortnight, of which the solar eclipse happened at the middle of the full-moon ending *Māgha*, and both the eclipses were visible from Śrāvasti, were :—

(1) A lunar eclipse on
December 29, —559 A.D. (560 B.C.). Julian day no. = 1517246. Full moon happened at 17 hrs. 30 m. G.M.T. or 23 hrs. 0 m. I.S.T. Magnitude of the eclipse = 6·8 Indian units.
Duration of the eclipse = 2 hrs. 40 mins.

[1] At this period of time a full moon at about 3° behind δ-*cancræ* gave the winter solstice day. For on December 27, 576 B C. at G M. Noon App. Sun = 270° 17′, App. Moon = 95° 57′ and δ-*cancræ* = 93° nearly. Full moon happened about 5-12 A.M. I.S.T. and Sun reached the winter solstice at about 10-45 A.M. I.S.T.

[2] The great book on eclipses by Oppolzer, Vienna, 1887.

(2) A solar eclipse on
January 14, –558 A.D (559 B C.), Julian day no. = 1517262.
New moon happened at 6 hrs. 38 m. G.M.T. or 12 hrs. 8 m. I.S.T.
Longitude of conjunction of Sun and Moon = 288°·401.

The central line of the *annular* eclipse passed through the three places A, B and C having the following longitudes and latitudes :—

Station	*Long.*	*Lat.*	*Location of Station*
A	30° E	35° N	150 miles west of Cyprus
B	80° E	31° N	Nanda Devi Peak of the Himalayas
C	119° E	57° N	A place in East Siberia.

Both these eclipses were visible from Śrāvastī in the district of Rae Barelli; the first was a partial eclipse of the moon and the second though an annular eclipse was a partial one at Śrāvastī. The sun had reached the winter solstice 18 days before the day of the solar eclipse, *i.e.*, on the 27th December, 560 B.C.

If we accept that the Buddha's *Nirvāṇa* happened in 544 B.C. or –543 A.D., the eclipses in question as referred to in the *Samyutta Nikāya* happened 15 years before that date. The other finding of the *Nirvāṇa* year as 483 B.C. becomes 76 years later than the year of the eclipses. If the tradition of the eclipses is true and our interpretation of the month of their happening be correct, the year 483 B.C. for the Buddha's *Nirvāṇa* is inadmissible. Here the Ceylon-Burma tradition as to the *Nirvāṇa*-year, *viz.*, 544 B.C., is really the true date of the great event.

CHAPTER XXII

INDIAN ERAS

Kaniṣka's Era

The eras used in the *Kharoṣṭhī* inscriptions are still a matter for controversy. Dr. Sten Konow in his celebrated edition of them in the *Corpus Inscriptionum Indicarum*, Vol. II, pp. lxxxii-lxxxiii, has collected together 36 instances of dates from these inscriptions and has divided them into two groups, A and B. The dates used in Group A belong to an earlier era, while those in Group B use the era or the regnal years of Kaniṣka. In this chapter we propose to ascertain the era used in this second Group B. Of the dates in this latter group only those which are found in Nos. 26 and 35 give us some clue as to the era used, *viz.*, 26 Zeda. *saṁ 11 Āṣāḍhasa masasa di 20 Utaraphagune is'a Kṣuṇami marodasa marjhakasa Kaṇiṣkhasa rajemi.*

35 Und. *Saṁ* 61 *cetrasa mahasa divasa athami di* 8 *ise Kṣunami Pūrvāṣāḍhe.*

These instances state that in the eleventh year of king Kaniṣka on the 20th day of lunar Āṣāḍha, the moon was conjoined with the *nakṣatra Uttaraphalgunī*, and that in the year 61, of Kaniṣka, the moon's *nakṣatra* was *Pūrvṣāāḍhā*, on the 8th day of *caitra*. From some examples of date in the *Kharoṣṭhi* inscriptions Dr. Konow has come to the conclusion that "the full-moon day must be the first day of the month," the chief example being that the first day of *Vaiśākha* was taken as the full-moon day of *Vaiśākha* (*saṁvatsare tiśatime* 103 *veśākhasa divase prathamime di atra puṇapakṣe*—No. 10, Group A of Konow's list). Here there is no room for a difference of opinion with Dr. Konow. But I have to say that this system of reckoning the full-moon ending lunar months is not Indian,—it may be Greek or it may be Babylonian. The month that is called *Vaiśākha* in this inscription would be called the full-moon ending

lunar *Jyaiṣṭha* according to the Indian reckoning. In the *Mahābhārata* also we have "the full-moon near the *Māgha* is about to come and the month of *Māgha* is also drawing to a close."[1]

Now accepting the reckoning of the full-moon ending months as reckoned in the inscriptions, the meaning is clear that the day that is spoken of as the 20th of *Āṣāḍha*, is the 5th day of new-moon ending *Śrāvaṇa* and the 8th day of *Caitra* is the 8th day of the dark half of *Caitra*. Hence we have the dates as:—

(*i*) Year 11, month *Śrāvaṇa*, 5th day, *Uttaraphalguṇī*.

(*ii*) Year 61, month *Caitra*, 23rd day, *Pūrvāṣāḍhā*

Dr. Fleet is of opinion that the well-known Śaka era and the Kaniṣka era are but one and the same era. Now the years 11 and 61 of the Śaka era are similar to the years 1925 and 1937 A.D. of our times in respect to luni-solar stellar aspects, and

(*a*) In 1925 A.D., on July 26, the moon's *nakṣatra* was *U. Phalgunī*, and it was the day of 5th *tithi* of light half of *Śrāvaṇa*.

(*b*) In 1937 A.D., on April 4, the moon's *nakṣatra* was *P. Āṣāḍhā*.

But the 4th April, 1937 A.D. is shown in modern Hindu calendars as the 8th day of the dark half of *Phālguna*. It may be observed, however, that the Vedic standard month of *Māgha*, came in the year 1935 from Feb. 3 to March 5, and that no intercalary month would be reckoned in those days of pre-scientific Hindu astronomy within the next 2½ years from Feb 3, 1935, as was done in the present-day Hindu calendars from Sep. 16 to Oct. 15, in the year 1936 A.D. Hence the lunar month that was called lunar *Phālguna* in the modern calendar for 1937, was called the month of *Caitra* according to this old reckoning. Hence from a purely astronomical standpoint, Kaniṣka's era and the well-known Śaka era may be identified with each other. But this Śaka era, started from 78 A.D., is perhaps to be associated with the death of a Śaka king as

1 *MBh.*, *Aśvamedha*, Ch. 85. 8 :—

माघी च पौर्णमासीयं मासः शेषो वृकोदरः ॥

Brahmagupta says—"**कलेर्गोऽगैकगुणाः (३१७९) शकान्तेऽब्दाः**." [1] The Kali years were 3179 (elapsed) at the death of the Śaka king." Again Brahmagupta calls the years of the Śaka era as "the years of the Śaka kings (**शकनृपाणाम् पञ्चाशत्संयुक्तैर्वर्षशतैः पञ्चभिरतीतैः**," [2] *i.e.*, when 550 years of the Śaka kings had elapsed). Hence the regnal years of king Kaniṣka may not be the same as the years of the Śaka era as used by the Hindu astronomers. It seems likely that the Śaka era was started with the death of the predecessor of Kaniṣka whose real accession to the throne came in the year 78 A. D., while his regnal years were reckoned from the year of his coronation. On this hypothesis Kaniṣka's regnal years or his era were started at a very short interval from 78 A.D.

In the *Paitāmaha Siddhānta* as summarised by Varāhamihira in his *Pañcasiddhāntikā*, the epoch used is the year 2 of the Śaka kings [3] :—

द्व्यूनं शकेन्द्रकालं पञ्चभिरुद्धृत्य शेषवर्षाणाम् ।
द्युगणं माघसिताद्यं कुर्य्यात् तदहरुदयात् ॥

" Deduct 2 from the year of the Śaka kings, divide the result by 5, of the remaining years, find the *ahargaṇa* from the beginning of the light half of *Māgha* starting from the sunrise of that day."

We can, now readily show that we may take the regnal years of Kaniṣka to have been started from this year 2 of the Śaka kings.

On this hypothesis, we have,

the year 2 of Śaka kings = 80 A.D.

∴ the year 11 of Kaniṣka = 91 A.D.

The year 91 A.D. is similar to the 1927 A.D. of our time for the No. of years lapsed = 1836, and $1836 = 160 \times 11 + 19 \times 4$. Hence the 20th day of *Āṣāḍha* of the inscription is similar to Tuesday, the 2nd August, 1927 A.D.

Again the year 61 of Kaniṣka = 141 A.D. and the year in our time similar to 141 A.D. is readily seen to be 1939 A.D., and

1 *B. Sphuṭasiddhānta*, i, 26.
2 *Ibid*, xxiv, 7.
3 *Pañcasiddhāntikā*, xii, 2.

that the date of the inscription corresponds to Tuesday, the 11th April, 1939 A.D.

Now the interval between 1939 A.D. and 1927 A.D.=12 years, whereas between the year 11 and the year 61 of Kaniṣka the interval is 50 years. Now as 50=19×2+12, the moon's phases near to the fixed stars which repeat in 50 years also do repeat in 12 years. It is therefore quite consistent to take king Kaniṣka's regnal years to have been reckoned from the year 2 of the Śaka kings.

It now remains (*i*) to determine how and when the year of the Śaka kings was taken to begin initially, (*ii*) why the lunar months were reckoned from the full-moon day itself, and (*iii*) to verify, by back calculation, the dates mentioned of the years 11 and 61 of Kaniṣka.

With regard to the first point, we know that in Vedic times the year was taken to begin from the winter solstice day or from the day following; in the Vedāṅga period also, the year was begun from the winter solstice day. As the time when the Śaka era came to be reckoned, was before that of Āryabhaṭa I (499 A.D.), we may reasonably assume that originally the Śaka year also was begun from the winter solstice day.

We assume further that the winter solstice day was correctly determined 5 years before the Śaka year 2 or 80 A.D. The number of tropical years between 75 A.D. and 1900 A.D.=1825, which comprise 666576 days nearly. On applying these days backward to Dec. 22, 1899 A.D., we arrive at the date Dec. 24, 74 A.D., on which at—

G. M. Noon—	Hence on Dec. 22, 74 A.D., at G.M.N.,
Mean Sun = 270° 56′ 21″·11	Mean Sun = 268° 58′ 4″·45
,, Moon = 121° 15′ 31″·75	Mean Moon = 94° 54′ 21″·69
Lunar Perigee = 231° 39′ 49″·94	L. Perigee = 231° 26′ 27″·83
Sun's Apogee = 69° 58′ 35″·32	Appt. Sun = 269° 38′
,, Eccentricity = ·01747191.	Appt. Moon = 91° 44′ nearly.

Thus on Dec. 22, 74 A.D. the full-moon happened about 4 hours before G. M. N., and the sun reached the winter solstice in about 7 hours.

This elucidates the points (*i*) and (*ii*), *viz.*, that the Śáka year was initially taken to begin from the winter solstice day, and why the months were reckoned from the full-moon day itself. In 75 A.D., the mean longitude of *Pollux* was 86°31′, nearly : the moon at opposition on Dec. 22, 74 A.D., had the longitude of about 89°28′, *i.e.*, about 3° ahead of the star *Pollux*, and the day was that of the full-moon of *Pauṣa*, and similar in our times to that which happened on Jan. 15, 1930.

The actual starting of the era of Kaniṣka may have taken place, on our hypothesis, from the full-moon day of Dec. 26 of 79 A.D. as the first day of lunar *Pauṣa*. This agrees with the statement of the inscription that the *Vaiśākha māsa* had the first day on the day of the full-moon near the *Viśākhās*. We shall also show later on that the *Saṁvat* months were also full moon ending.

Having thus shown why the era of Kaniṣka may be taken to have been started from the 26th December, 79 A.D., we now turn to determine the date for *Saṁ 11, Āṣāḍha māsa, di 20, Uttaraphalgunī*. Evidently the date was similar to Aug. 2, 1927 A.D., and between these years the interval was 1836 years, which comprise 670611 days nearly. We apply these days backward to Aug. 2, 1927 A.D. and arrive at the date, July 8, 91 A D., and on July 7, 91 A.D. at G. M. N.,

Mean Sun = 104° 14′ 50″·20	Hence—
,, Moon = 146° 41′ 3″·90	Appt. Sun = 103° 7′
Lunar Perigee = 184° 37′ 5″·67	,, Moon = 142° 36′
Sun's Apogee = 70° 15′ 34″·87	and the "junction star"
,, Eccentricity = ·017466.	*U. Phalgunī* = 144° 46′.

Again 19 days before this date, *i.e.*, on June 19, 91 A.D., at G. M. N.—

Mean Sun = 85° 31′ 11″·93	Hence—
,, Moon = 256° 12′ 54·53	Apparent Sun = 85° 0′
Lunar Perigee = 182° 30′ 5″·64	,, Moon = 261° 12′

Thus the full-moon happened about 8 hours later, and this was the first day of the month. Hence the 8th of July, 91 A.D. was the 20th day of *Āṣāḍha*, and it has been made clear that the moon on this day got conjoined with *β Leonis* or *Uttaraphalgunī* in the evening. *The date of the inscription was thus July 8, 91 A.D.*

Next as to the year 61 of Kaṇiṣka = Śáka year 63 = 141 A.D., the moon on the 8th day of the dark half of *Caitra* was conjoined with the *nakṣatra Pūrvāṣāḍhā*. The day in question was similar to April 11, 1939 A.D. of our time. The number of years between 141 A.D. and 1939 A.D. was 1798, and in 1798 sidereal years there are 656731 days. These days applied backward to April 11, 1939 A.D., lead us to the date—

March 17, 141 A.D., on which at G. M. N.,

Mean Sun = 353° 44′ 43″·00	Hence—
,, Moon = 258° 15′ 1″·12	Appt. Sun = 355° 41′
Lunar Perigee = 46° 46′ 56″· 27	,, Moon = 254° 14′, and
Sun's Apogee = 71° 6′ 27″ 69	*P. Āṣāḍhā* = 248° 43′
,, Eccentricity = ·017447.	(*δ Sagittarii*)

Here the conjunction of the moon with *δ sagittarii* on this day was estimated in the previous night. The day in question was of the 7th *tithi* according to the *siddhāntas*, and the day of the last quarter was the day following ; but this day was the 8th day of the month.

For on the 10th March, 141 A.D., at G. M. N.,

Mean Sun = 346° 50′ 44″·70	Hence the full-moon had happened about 3 hrs. earlier.
,, Moon = 166° 0′ 55″·92	
Lunar Perigee = 46° 0′ 9″·50.	

This was the full-moon day and the 1st day of *Caitra* ; hence the 17th March was the 8th day of the month.

Thus we see that the hypothesis that the era of King Kaniṣka was started from Dec. 25 of 79 A.D. or from the year 2 of the Śáka era, satisfies all the conditions that arise from the dates given in the *Kharoṣṭhī* inscriptions, Group B, of Dr. Konow. The

present investigation shows that the Śáka emperor Kaniṣka lived at the beginning of the Śáka era, a view which, I hope, would be endorsed by all right-minded historians and it would not go against Dr. Fleet. When this solution of the problem is possible, we need not try to find others leading to other dates for the beginning of Kaniṣka's regnal years.

Dr. Van Wijk, the astonomical assistant to Dr. Konow, has tried to show that the era of Kaniṣka was started from 128 A.D., and would identify the regnal year 11 of Kaniṣka with 139 A.D. He based his calculation on the modern *Sūrya siddhānta*, which cannot be dated earlier than 499 A.D. Without examining his calculations we can say that his findings are vitiated by the following grounds:—

(*a*) The *Caitra śuklādi* reckoning of the year as found in the modern *Sūrya siddhānta*, cannot be applicable to the early years of Śáka era and Kaniṣka's regnal years which were prior to 499 A.D.

(*b*) The word " day of the month " means simply a day and is not to be confounded with a *tithi* as used in the modern *Sūrya siddhānta*.

(*c*) The word "*nakṣatra*" mentioned in these inscriptions meant very probably " star clusters " and not $\frac{1}{27}$th part of the ecliptic.

For these reasons I have used the most accurate or up-to-date equations for finding the sun and the moon's mean elements instead of following the *Sūrya siddhānta*. The luni-solar periods used in this investigation are also most accurate and deduced from the constants as given by Newcomb and Brown. It has been shown that the days of the month are also " days " and not *tithis* and *nakṣatras* mean " star clusters " and not equal divisions of the ecliptic. I have taken the data from the inscriptions as actually observed astronomical events.

It seems that Dr. Van Wijk has done disservice to himself, to Dr. Konow and to history by lowering the era of Kaniṣka, as to its beginning, to a very improbable date of about 128 A.D. In our opinion he should have made a thorough study of the history of Indian astronomy before making any chronological calculations for any date prior to 499 A.D.

CHAPTER XXIII

INDIAN ERAS

Earlier Era of the Kharoṣṭhī Inscriptions

We have in the preceding chapter shown that Kaniṣka succeeded to the throne most probably in the year 78 A.D., and that his regnal years or his own era was started from 80 A.D. In the present chapter we shall try to ascertain the era or eras used in Dr. Konow's list (A) in his *Inscriptionum Indicarum*, Vol I, page lxxxii, of the instances of dates of the earlier *Kharoṣṭhi* inscriptions. This list contains 23 dates of the inscriptions; the 23rd states the year as

23. Skāra Dheri : *Vasa ekunacaduśatime* (399), *Āṣāḍha māsasa divase* 22.

In the Taxila copper plate of the year 78, the Greek month *Panemos* is used and stated as "*Panemasa māsa*". These 23 inscriptions record years serially from 58 to 399. It is for the archeologists to pronounce whether it would be rational to take all these instances as belonging to the same era. One outstanding fact is the statement in No. 23, that the year is mentioned as 399. Further the months are taken to begin on the full-moon day; the *Vaiśākha māsa* had its first day on the day of the full-moon near the *Viśākhās*. Such a month in the strictly Indian calendar would be called *Jyaiṣṭha* (and not *Vaiśākha*) full-moon ending. Hence the month of *Pauṣa* of these inscriptions began on the full-moon day of *Pauṣa* and ended on the day before the full-moon of *Māgha*. The year of these inscriptions began as in the case of the Mālava and Śāka eras with the full-moon of *Pauṣa*; the types of *Pauṣa* of these were, of course, different.

Now deducting 80 from 399, we arrive at the year at about 320 B.C. Again the shifting of the equinoxes and the solstices till 1940 A.D. becomes about 31° 24′ nearly. Hence what was the longitude of the sun of 270° in the year 320 B.C. would in

year about 1940 A.D ., become 301° 24′ nearly, a longitude which the sun has on the 22nd of January nowadays.

On looking up some of the recent calendars we find that there was a full-moon on January 23, 1932. Now the number of years from 320 B.C. to 1940 A.D. = 2259 years and 2259 = 1939 × 1 + 160 × 2. Hence 2259 sidereal years represent a complete luni-solar cycle comprising 825114 days. We apply these days backward to January 23, 1932 A.D. and arrive at the date

December 26, 329 B.C., on which at G. M. T. 0 hr.,

Mean Sun	=269°52′7″·16,	Hence—
Mean Moon	=90°59′59″·31,	Appt. Sun=270°48′
Lunar Perigee	=72°48′8″·65,	Appt. Moon=92°36 nearly.
Sun's Apogee	=63°7′11″	F. M. had happened about 3½
Sun's Eccenticity	=·017613	hrs. before and the sun reached
2e=121′.098, $\frac{5}{4}e^2$	=1′·334	the winter solstice 19 hrs. before.

Thus Dec. 25, 329 B.C., was a full-moon day according to the Indian mode of reckoning of those days, and it was the day of the winter solstice as well. Hence the year could be begun astronomically from this date which was both a full-moon day and the day of winter solstice. This means virtually starting the era from the year 328 B.C., Jan. 1. This year almost synchronised with the year of the Indian expedition of Alexander the Great. If, however, it is considered that the year was started, not from the winter solstice day but from the day, following we find that—

On Dec. 26, 310 B.C., at G.M.N.,

Mean Sun	=269°45′56″·90,	
Mean Moon	=88°35′38″·90	Hence—
Lunar Perigee	=125°56′19″·55	Appt. Sun =270°41′
Sun's Apogee	=63° 26′47″	Appt. Moon=85°15′ nearly.
Sun's Eccentricity	=017613	

We readily see that the full-moon came in about 9 hrs. more, and this date was the day following the winter solstice. If the era, of which we want to find the beginning, was really started from such a correct determination of the winter solstice day on this 26th of Dec. 310 B.C. The 1st day of lunar months would

be a full-moon day. On the whole this date was most favourable for the starting of the era of the earlier *Kharoṣṭhī* inscriptions The usual practice, however, of beginning an era was to reckon it from 5 years later. Hence the actual reckoning of the era was probably made from the full-moon day of about Dec. 29, 305 B.C.

Now we know that Seleucus's era was contemplated from about 312 B.C., and was actually started from the year 305 B.C. It would thus appear that the era which the earlier *Kharoṣṭhī* inscriptions use may in all probability have been this era.

Hence—

The *Kharoṣṭhī* Inscription year—

58	represents	247 B.C.
78	,,	227 B.C.
103	,,	202 B.C.
136	,,	169 B.C.
187	,,	118 B.C.
384	,,	80 A.D.
399	,,	95 A.D.

The archaeologists alone may say if this determination represents the nearest approach to reality. If we accept the hypothesis that the era used in these inscriptions is really the era of Seleucus Nikator, who in all probability is referred to as the Mahārājātirāja, there would be a slight overlapping of it with the era of Kaniṣka started from 80 A.D., which is permissible. If the *Kharoṣṭhī* inscriptions here use the era of Alexander the Great, this was probably started from about 327 A.D., there would be no overlapping with Kaniṣka's era. My own independent view is that Seleucus's era meets all the conditions of the era used in these inscriptions and the slight overlapping with Kaniṣka's era is permissible, as has been said before. If Dr. Konow has not really been able to get at a true chronological order in making up his List A, some of the inscriptions might belong to other eras of later beginning.

Next we have to consider the interpretation of Dr. Luders, who has opined that the era of Mahārājātirāja 292 or 299 was

really the Parthian era started from 248-247 B.C.[1] We have to differ from him. Kaniṣka's era could not have been started from 128 A.D. as has been shown in the preceding chapter. Dr. Van Wijk is wrong in his calculation. There was no one king in these days who was styled Mahārājarājatirāja. Kaniṣka was one and another was a Kuṣāṇa (Taxila silver scroll of the year 136). The title in its Greek form was very probably first assumed by Seleucus Nikator. The same title may have been assumed by or ascribed to the great Maurya Emperor Aśoka. Our results of calculation are set forth below:

On Dec. 26, 272 B.C., at G. M. T. 0 hr.,

Mean Sun = 270° 3′ 10″·72,	Hence—
,, Moon = 90° 21′ 38″·07,	Appt. Sun = 270°57′,
Lunar Perigee = 64° 6′.	,, Moon = 87°25′, nearly.
Sun's Eccentricity = ·017613.	

It was the day following the winter solstice day, and the full-moon (of *Pauṣa*) came in about 7 hrs. more. Thus this date was quite suitable for the starting of a new era. The date shows a peculiar coincidence with that of Aśoka's accession to the Maurya Empire. The real starting of Aśoka's regnal years may have been started five years later, from about Dec. 29, 267 B.C. It is again not unlikely that an era may have been started by Chandragupta Maurya, the grandfather of Aśoka, from about,—321 A.D. We are here dealing with probabilities, but we must not forget that the last year recorded in the *Kharoṣṭhī* inscription of Skāra Dehri was the year 399, and there should not be much overlapping between the regnal years of Kaniṣka, and this older era of the *Kharoṣṭhī* inscriptions. Of Kaniṣka the first regnal year can not much move from 78 A.D., the zero year of the Śaka kings. The luni-solar phenomenon which led Dr. Van Wijk to identify the regnal year 11 of Kaniṣka with 139 A.D., was true also for the year 90 A.D. This would make the regnal years of Kaniṣka possible for being started from 79 A.D. It is well known that such luni-solar phenomena repeat in cycles of both 19 and 11 years. The 49 years which intervene between 139 A.D.

[1] Cf. *Ācārya-puṣpāñjali*, published by the Indian Research Institute, Calcutta, 1940, page 288.

and 90 A.D., comprise two cycles of 19 years and one cycle of 11 years. There can thus never be any possibility for an absolute fixing of the date of any past event by such luni-solar phenomena or events. We have also to respect the tradition and also to depend on the position of the equinoxes or of the solstices if either is discernible or can be settled. Dr. Konow and his astronomical assistant Dr. Van Wijk have shown a total disregard for tradition and the latter has depended on a very slender evidence like a simple luni-solar event. This can not but be called irrational and no chronologist would lend his support to such a finding.

As to Dr. Van Wijk's identifying the regnal years 11 and 61 of Kaniṣka with 139 A.D. and 189 A.D., we can readily examine the validity thereof in the following way :—

The luni-solar cycles according to the *Sūryasiddhānta* are 3, 8, 19, 122, 263, 385 and 648 years. Hence the Christian years in present times which were similar to 139 A.D. and 189 A.D. are respectively 1923 A.D. and 1935 A.D. The day which corresponds to *Āṣāḍha māsasa di 20 Uttaraphalgunī* of the regnal year 11 of Kaniṣka, was July 18, 1923 ; while the date *Saṁ 6, Chetrasa māhasa divasea aṭhamā di 8*, corresponds to March 28, 1935. From the calendars for these years it is clear that Dr. Van Wijk has used the Indian full-moon ending lunar months in place of those which are directly indicated in the *Kharoṣṭhī* inscriptions. On this point I invite the attention of the reader to the finding of Dr. Konow quoted below :—

" We are on safer grounds when we want to ascertain whether the months began with full or new moon. The Zeda inscription of the year 11 is dated on the 20th of *Āṣāḍha* and the *nakṣatra* is given as *Uttaraphalgunī*. Prof. Jacobi has kindly informed me of the fact that the *nakṣatra* belongs to the *Śukla pakṣa*, where it may occur between the fifth and the eighth day. If, therefore, the twentieth day of the month falls in the beginning of the bright half, in our case the fifth day after the new-moon, the full-moon day must be the first day of the month.

The same result can apparently be derived from the Takt-i-Bahi inscription, where the first *Vaiśākha* seems to be characterised as *(puña) pakṣa*, evidently because it was the

Buddha's birth-day, which tradition sometimes gives as the full-moon of *Vaiśākha*."[1]

If the first day of *Vaiśākha* was the full-moon day of *Vaiśākha*, then what is lunar *Vaiśākha* of the *Kharoṣṭhī* inscriptions would end on the day before the full-moon of *Jyaiṣṭha*. Such a month is called in the Hindu calendar, not *Vaiśākha* but *Jyaiṣṭha*. The corresponding dates in our own times of the 20th *Āṣādha Saṁ* 11, and the 8th of *Caitra* of *Saṁ* 61 of the inscriptions, which were taken respectively as July 18, 1927 and March 28, 1935, would show that Dr. Van Wijk has misunderstood the meaning of these peculiar lunar months of the *Kharoṣṭhī* inscriptions.

We understand that the earlier era of the *Kharoṣṭhī* inscriptions was really Seleucidean era reckoned from the year 311 B.C. The era may also be that of Chandragupta started from the year about 321 B.C. or it may also be that of Aśoka the Great, first determined from the year 272 B.C., but started later on from 267 B.C. It cannot be Parthian era, as Kaniṣka's date of accession must be very near to the year 78 A.D., and his regnal years in all probability started from 80 A.D., the epoch of the *Paitāmahasiddhānta*. As to Dr. Luders's view on this point we can say that the donors of the Mathura inscription of the year 292 may be Greek, but the inscription was made intelligible for other people, *viz.*, the Indian; the era in question may more likely be that of Chandragupta or of Aśoka the Great. Too much overlapping of the two eras is, however, inadmissible. The era in question most probably was the Seleucidean era.

1 Konow's Introduction to *Corpus Inscriptionum Indicarum*, Vol. II., p. lxxxiv.

CHAPTER XXIV

INDIAN ERAS

The Saṁvat or the Mālava Era

In this chapter it is proposed to discuss three points in relation to the Mālava or the Saṁvat era : (*i*) how it was started initially with the mode of reckoning the year, (*ii*) why it is called *Kṛta* era and (*iii*) why in the Mālava or the Vikrama Saṁvat 529, on the second day of the lunar month of *Tapasya* or *Phālguna*, the Indian season of spring is said to have already set in, as we have it in Fleet's Gupta Inscriptions, Plate No. 18.

This era, which is at present better known as the Vikrama Saṁvat, has its year-beginning from the light half of lunar *Caitra* according to the rule of the scientific *siddhāntas* or treatises on astronomy, all of which are of different dates which cannot be earlier than 499 A.D. In the preceding chapters, it has been shown that from the earliest Vedic times, the year was taken to begin from the winter solstice day ; the *Vedāṅgas* also followed the same rule. It was perhaps so, also with Christian era initially. We now proceed to discover how this Mālava or the Saṁvat era was started initially, on this hypothesis, from the winter solstice day.

Initial Starting of the Era

Now, 1997 of Saṁvat era = 1940-41 of the Christian era
∴ 0 year of Saṁvat era = —57 of the Christian era
= 58 B.C.

From 58 B.C. to 1940 A.D., the mean precession rate was $= 50''{\cdot}0370$ per year, and in 1997 years, the total precession of the equinoxes and solstices has been $= 27°45'24''$ nearly. Hence what was 270° of the longitude of the sun about 58 B.C., is now about $297°45'27''$, which is the present-day longitude of the sun about the 19th of January.

Now, 1997 years = 1939 yrs. + 19 × 3 years + 1 yr. Hence we get an accurate luni-solar cycle of 1996 years. Further 1996 sidereal years = 729052 days nearly. We apply these days backward to Jan. 20, 1939 A.D. and arrive at :—

(1) The date, Dec. 25, 59 B.C., on which at G. M. N.,

Mean Sun = 270° 55′ 29″·86,
,, Moon = 260° 54′ 57″·65,
Lunar Perigee = 260° 10′ 8″·99.

Here the new-moon fell on the the 26th December, and not on the winter solstice day which was the 24th December. It is unlikely the Saṁvat year reckoning had its origin from such a new-moon day.

(2) Secondly a full-moon happened on Jan. 19, 1935 A.D. ; then by a process similar to that shown above we arrive at :—

The date, Dec. 25, 63 B.C., on which at G. M. N.,

Mean Sun = 270° 53′ 39″·15,
,, Moon = 90° 12′ 12″·27,
Lunar Perigee = 97° 22′ 56″·91,
Sun's Apogee = 67° 39′ 24″·69.
,, Eccentricity = ·0175223.

The full-moon no doubt happened on this date, but it was the day following the winter solstice. If year-reckoning was started on the basis of the correctly ascertained winter solstice day of this year, the lunar months would be reckoned to begin from the full-moon day of the lunar *Pauṣa*, as in the *Kharoṣṭhī* inscriptions, as we shall see later on. The distinguishing character of this *Pauṣa* was that the full-moon was conjoined with the 'junction star' *Punarvasu* (*β Gemniorum*) very nearly. We, however, try to find the full-moon or the new-moon which happened exactly on the winter solstice day.

(3) We go up by 8 years or 99 lunations from Dec. 26, 59 B.C., and arrive at :—

The date, Dec. 24, 67 B.C., on which at G.M.N.,

Mean Sun = 269° 52′ 40″·10,	
Mean Moon = 266° 18′ 52″·09,	The corresponding
Lunar Perigee = 294° 29′ 57″·00,	date in our time—
Sun's Apogee = 67° 35′ 19″	Jan. 19, 1931.
,, Eccentricity = ·017524	

Here the new-moon happened on the day following, *i.e.*, on the 25th Dec., the day after the winter solstice.

(4) We next go up by 8 years or 99 lunations from Dec. 25, 63 B.C. and arrive at :—

The date Dec. 24, 71 B.C., on which at G.M.N.,

Mean Sun = 269° 50′ 53″·49,	The corresponding
,, Moon = 95° 36′ 6″·54,	date in our time—
Lunar Perigee = 131° 43′ 18″·00.	Jan. 17, 1927.

Here the full-moon and the sun's reaching the winter solstice fell on the same day, and the full-moon was conjoined with the 'junction star' of *Punarvasu* or β *Gemniorum*, and this was the distinguishing mark of the winter solstice day. The practice was, probably, to intercalate one lunar month occasionally on the return of the similar full-moon near β *Gemniorum*. This is on the assumption that the year was begun from the dark half of *Pauṣa*.

(5) Lastly to finally examine if the new-moon and the winter solstice fell on the same date, we find that on :—

The date Dec. 23, 75 B.C., at G.M.N.,

Mean Sun=268° 49′ 57″·16	The corresponding date
Mean Moon=271° 42′ 46″·21	in our time—
Lunar Perigee=328° 49′ 58″·00	Jan. 17, 1923 A.D.

The new-moon happened on this day but it was the day before the winter solstice.

On the whole it is not impossible to infer that the year of the Saṁvat era used also to be reckoned from the light half of *Māgha*, *i.e.*, from a day which was like the new-moon day of Jan. 17, 1923 of our time ; the distinguishing character of this *Māgha* was that its first quarter was conjoined with β *Arietis*, the

'junction star' of the *nakṣatra Aśvinī*. Perhaps the Indian orthodox reckoning also started from the light half of the lunar *Māgha* of this type, while the *Kharoṣṭhī* inscriptions have the reckoning from the very full-moon day itself of lunar *Pauṣa*, with the distinguishing feature found in (2) and (4).

The winter solstice day which just preceded the year 58 B.C., was the 24th Dec., 59 B.C. The new-moon near this date fell on the 26th. It appears that the Saṁvat or rather the Mālava era did not actually begin with 58 B.C., but most probably from 57 B.C., and that Saṁvat years are not years elapsed, but are, like the Christian years, the current ones. This will be clear from the next topic dealt with, *viz.*,

(ii) *Why the Saṁvat Years are called Kṛta Years.*

The oldest name of the Saṁvat years was also *Kṛta* years, as has been noticed by all the Indian archaeologists from Dr. Fleet up to Dr. D. R. Bhandarkar and others of later times. We propose to find the reasons thereof in this part of the chapter.

(1) According to all Indian Calendars, the *Kṛtayuga* began (*a*) on a Sunday which was (*b*) the third day of the of the lunar *Vaiśākha* and (*c*) on which the moon was conjoined with the *Kṛttikās* or *Pleiades* according to the *Purāṇas*.

The *Matsya Purāṇa* says:

वैशाखमासि शुक्लायां तृतीयायां जनार्दनः ।
यवानुत्पादयामास युगञ्चकृतवान् कृतम् ॥

"God Viṣṇu caused barley to ripen on the third day of the light half of lunar *Vaiśākha* and started the *Kṛtayuga*."

The same *Purāṇa* also says:

वैशाख शुक्लपक्षे तु तृतीयायैरूपोषिता ।
अक्षयंफलमाप्नोति सर्वस्यसुकृतस्य च ॥
सा तथा कृत्तिकोपेता विशेषेण सुपूजिता ।
तत्र दत्तं हुतं जसं सर्वमक्षयमुच्यते ॥ Ch. 65, 2-3.

"Those people who have fasted on the third day of the light half of lunar *Vaiśākha*, would earn inexhaustible merit for it and for all other good deeds. If this day be the one on which the moon is conjoined with the *Kṛttikās* (*Pleiades*), it is the most valued of

all: whatever be given away either as charity or as oblations to the gods, or whatever be done by repeating the prayer, has been declared by the wise as of unending religious merit."

The first signal for the beginning of the *Kṛta* era, therefore, was that the day should be the third of the light half of lunar *Vaiśākha*, should be a Sunday and should also be the day on which the moon was conjoined with the *Pleiades* group.

The second signal for the beginning of the *Kṛtayuga* according to the *Mahābhārata* and the *Purāṇas*[1] was :

यदाचन्द्रश्च सूर्य्यश्च तथा तिष्यवृहस्पती ।
एकराशौ समेष्यन्ति प्रपत्स्यते तदाकृतम् ॥

" The *Kṛtayuga* would begin when the sun, moon, Jupiter and the *nakṣatra tiṣya* (*Puṣyā*) would come into one cluster (*rāśi*)."

Astronomically speaking, the condition for both these aspects to happen in one year for the beginning of the *Kṛtayuga*, would not perhaps lead to any single solution; but we are here to look for a year near about 57 B.C., in which both these events occurred. That year has come out from my investigation to have been the year 63 B.C.

(1) In this year, the lunar *Caitra* ended on March 20, 63 B.C.

(*a*) On this day, at G. M. N.,

Mean Sun = 354° 54′ 48″·57,	Hence—
,, Moon = 360° 48′ 45″·69,	Appt. Moon = 356°7′
Lunar Perigee = 66° 11′ 49″·71,	,, Sun = 356°49′
Sun's Apogee = 67° 39′	
,, Eccentricity = ·017522.	

The new-moon happened at about 6-30 p.m. of Ujjayinī mean time.

(*b*) On March 21, 63 B.C., at G. M. N.,

Mean Sun = 355° 53′ 56″·90,	Hence—
,, Moon = 13° 53′ 20″·72,	Appt. Moon = 10° 17′
Lunar Perigee = 66° 18′ 30″·76	,, Sun = 357° 48′

The first *tithi* of the *siddhāntas* was over about 4 p.m., of Ujjayinī mean time, and the crescent moon was visible after sunset most probably.

[1] *Mbh.*, *Vana*, 190, 90-91.

(c) On Sunday, March 22, 63 B.C. (J. D.=1698493), at G.M.N.,

Mean Sun $=356° 53' 4''·23$,		Hence—
,, Moon $= 27° 9' 55''·75$,		Appt. Moon $=24° 37'$,
Lunar Perigee $= 66° 25' 11''·81$.		,, Sun $=358° 46'$,

and the *Kṛttikā* (*η Tauri*)$=31°$ $26'$ nearly.

The *siddhāntic* second *tithi* was over at about 1-20 p.m. of Ujjayinī mean time. According to the state of Hindu astronomy of that time the second day of the lunar *Vaiśākha* was taken to end with the setting of the moon on this Sunday evening, and the third day began. When both the moon and the *Kṛttikā* cluster became visible after sunset, they were separated by about 6° of longitude. It could be thus inferred that the moon would overtake the *Kṛttikās* in about half a day. This was probably regarded as the first signal for the beginning of the *Kṛtayuga*.

If we think that the connecting of the day of the week, *viz.*, Sunday, in the signal for the *Kṛtayuga* to begin, was a later addition, we have one further aspect to consider, that on the day following, the sun reached the **Vernal equinox** and this was the third day of the light half of *Vaiśākha*. This event was perhaps a more forceful signal for the beginning of the *Kṛtayuga*.

As to a very early use of the days of the week in the Hindu calendar, we have the following well-known passage in the *Hitopadeśa*:

"सखे स्नायुनिर्मिता एते पाशाः तदद्य भट्टारकवारे कथमेतान् दन्तैः स्पृशामि।"

"Friend, these strings (of the net) are made of guts; how can I then touch them with my teeth to-day which is a Sunday?" The rule was "No meat on Sundays." But we can not be sure of the date of the *Hitopadeśa*.

It is thus not quite rational for us to assume that the week-days were reckoned in the Hindu calendar about the year 57 B.C. But it is clear that the event of the sun's reaching the vernal equinox on the third day of lunar *Vaiśākha* would be regarded as of very special significance for the coming of the *Kṛtayuga*.

(2) Secondly this year, 63 B.C., was perhaps called the beginning of the *Kṛtayuga* for the coming of another astronomical event in it.

On June 16, 63 B.C., at G. M. N., we had—

Mean Sun	= 81° 38′ 59″·72,	Hence—
,, Moon	= 80° 20′ 8″·16,	Appt. Moon = 80° 45′
Lunar Perigee	= 76° 0′ 2″·58,	,, Sun = 81° 11′
Sun's Apogee	= 67° 39′,	Jupiter as corrected by the
Mean Jupiter	= 80° 52′ 26″·87,	equation of apsis,
Jupiter's Perihelion	= 341° 34′ 32″,	= 85° 54′ 54″.
,, Eccentricity	= ·0443845.	*ν Cancri* = 97° 5′.

Jupiter had set already and the new-moon happened in the *nakṣatra Punarvasu* ; the Jovial year begun was thus *Pauṣa* or *Mahāpauṣa*. The longitude of the oldest first point of the Hindu sphere was about, – 6° in this year and consequently the longitude of the first point of the *Puṣyā* division was = 87°20′. Jupiter was very near to this point. It may thus be inferred that the signal from Jupiter's position as to the beginning of the *Kṛtayuga* was taken to occur on this date, *viz.*, June 16, 63 B.C.

Again on July 16, 63 B.C., at G.M.T. 0 hr., or exactly one synodic month later—

Mean Sun	= 110° 43′ 37″·39,	Hence—
,, Moon	= 109° 2′ 21″·48,	Appt. Moon = 110° 57′,
Lunar Perigee	= 79° 17′ 13″·71,	,, Sun = 109° 23′,
Mean Jupiter	= 83° 19′ 35″·21.	Jupiter as corrected by the eqn. of apsis = 88° 19′.

On this day also the sun, moon, Jupiter and the *nakṣatra Puṣyā* were in the same cluster. This day also most probably afforded another signal for the coming of the *Kṛtayuga*. Jupiter had become heliacally visible about 10 days before.

If we go forward by 12 lunations from the above date, we arrive at July 5, 62 B.C., on which, at G.M.N.,

Mean Sun	= 100° 8′ 20″·52,
,, Moon	= 100° 4′ 19″·20,
,, Jupiter	= 112° 47′ 44″·98.
δ Cancri	= 100° 4′ nearly.

Here was another combination of the planets, which might have persuaded men that the *Kṛtayuga* had begun.

On the whole it is thus established that both the luni-solar, and the luni-solar-Jovial-stellar combined signals for the beginning of the *Kṛtayuga*, could be observed and estimated in the year 63 B.C. In this year the sun's reaching the winter solstice happened on Dec. 24, and the full-moon

day of *Pauṣa* was the day following it. The actual starting of the *Kṛta*, *Mālava* or the *Saṁvat* era was made 5 years later from the full-moon day of about the 28th Dec., 58 B.C. The *Saṁvat* year 1 was thus almost the same as 57 B.C., and that the number of the *Saṁvat* era represents the current year as in the Christian era. Further the lunar months here are full-moon ending as originally in the Śaka era, as we have seen in the preceding chapters. The year was reckoned from the full-moon day of *Pauṣa*. In 499 A.D. or some years later than this date, the *Caitra-Śuklādi* reckoning was followed according to the rule of Āryabhaṭa. But in the *Saṁvat* era, we are told that the lunar months are still reckoned as full-moon ending, which is now a case of a queer combination of opposites. We next turn to solve the last problem from the epigraphic source in relation to this era.

Mālava Saṁvat 529, the Second Day of the Light Half of Phālguna and the Beginning of Spring

In Fleet's Gupta Inscriptions, Plate No. 18, it is stated that spring had set in on the second day of the light half of *Phālguna* of the Mālava *Saṁvat* 529 or 473 A.D. Now the year in our time which was similar to 529 of the Malava era was 1932 A.D., and the date, to March 9, 1932. Elapsed years till this date was=1459 sidereal years=18046 lunations=5320909 days. These days are applied backward to March 9, 1932 A.D., and we arrive at the date :—

Feb. 15, 473 A.D., on which, at the Ujjayinī mean midnight,

Mean Sun	=326° 58′ 38″·09,	Hence—
,, Moon	=355° 57′ 22″·72,	Appt. Sun=328° 48′ 24″,
Lunar Perigee	=233° 43′ 28″·68,	,, Moon=360° 20′
Sun's Apogee	= 76° 46′ 14″·81,	nearly.
,, Eccentricity	=·017323.	

Now the Indian spring begins, when the sun's longitude becomes 330°, which happened about 30 hours later, *i.e.*, on the 17th Feb., 473 A.D. The local conditions probably brought in spring earlier.

Again 2·5 days before Feb. 15, 473 A.D., at Ujjayinī mean midnight, or on the 13th February, 473 A.D.. at Ujjayinī mean midday :—

Mean Sun	=324° 30′ 47″·25,
Mean Moon	=323° 0′ 55″·12,
Lunar Perigee	=233° 26′ 46″·04.

It appears that the new-moon had happened about 3½ hrs. before, and the first visibility of the crescent took place on the evening of the next day, the 14th Feb. Thus Feb. 15 was the second day of the month, as stated in the inscription.

We now proceed to consider why there has been an error in estimating the beginning of spring, which according to an old rule should come 60 days after the winter solstice day. We find that 60 days before this date, *viz.*, Feb. 15, or, on :—

Dec. 17, 472 A.D., at Ujjayini mean midday,

Mean Sun	=267° 20′ 37″,
,, Moon	=284° 48′ 4″,
Lunar Perigee	=226° 59′ 5″.

The estimated winter solstice day was thus premature by about two days. On this day, the first visibility of the crescent took place in the evening. Hence the second day of the light half of *Phālguna* was the estimated beginning of spring, *i.e.*, 60 days later. The new-moon happened on the 16th December and the real winter solstice day was the 19th December.

This inscription shows that the Gupta era cannot be identified with the *Saṁvat* era. The point that why or how the Mālava era came to be called Vikrama *Saṁvat* cannot be answered from any astronomical data,

Note.—We have here tried to interpret the astronomical statement of the Mandasor stone inscription of Kumara Gupta and Bandhuvarman. The date of the inscription found here as Feb. 15, 473 A.D., was that of the thorough repair and decoration of the sun temple at Mandasor (24°3′N and 75°8′E). The inscription says that spring has set in.

CHAPTER XXV

INDIAN ERAS

The Gupta Era

In the present chapter, it is proposed to determine the beginning of the era of the Gupta emperors of northern India. Dr. Fleet in his great book *Inscriptionum Indicaram*, Vol. III, has published a collection of the Gupta inscriptions. In order to verify the dates in those inscriptions he had the assistance of the late Mr. S. B. Dīkṣita of Poona, and his calculations led Dr. Fleet to conclude that the Gupta era began from 319-21 A.D.[1] This indefinite statement or inference is not satisfactory. Mr. Dīkṣita was also not able to prove that the Gupta and Valabhī eras were but one and the same era.[2] Of recent years some have even ventured to prove that the Gupta era is to be identified with the *Saṁvat* or Mālava era. Hence it has become necessary to try to arrive at a definite conclusion on this point, *viz.*, the true beginning of the Gupta era.

The tradition about this era is recorded by Alberunī, which is equivalent to this:—From the Śaka year, deduct 241, the result is the year of the Gupta kings and that the Gupta and Valabhī eras are one and the same era.[3] Now the Śaka era and the *Saṁvat* or Mālava era are generally taken to begin from the light half of lunar *Caitra*. As has been stated already, it is extremely controversial to assume if this was so at the times when these eras were started.

From the earliest Vedic times and also from the *Vedāṅga* period, we have the most unmistakable evidences to show that the calendar year, as distinguished from the sacrificial year, was

1 Fleet—*Corpus Inscriptionum Indicarum*, Vol. III (Gupta Inscriptions), page 127.

2 S. B. Dīkṣita, भारतीय ज्योतिःशास्त्र, page 375 (1st Edn.).

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started either from the winter solstice day or from the day following it. The so-called *Caitra-Śuklādi* reckoning started the year from the vernal equinox day or from the day following it. So far as we can see from a study of the history of Indian astronomy, we are led to conclude that this sort of beginning the year was started by Āryabhaṭa I from 499 A.D. The great fame of Āryabhaṭa I, as an astronomer, led all the astronomers and public men of later times to follow him in this respect. We start with the hypothesis that the Gupta era was originally started from the winter solstice day and that initially the year of the era more correctly corresponded with the Christian year, than with the *Caitra-Śuklādi* Śaka year

Now the year 241 of the Śaka era is equivalent to 319-20 A.D. We assume that the Gupta era started from the winter solstice day preceding Jan. 1, 319 A.D. The elapsed years of the Gupta era till 1940 A.D., becomes 1621 years and $1621 = 160 \times 10 + 19 + 2$. Hence the starting year of the era was similar to 1938 A.D. Now the mean precession rate from 319 to 1938 A.D. = 50″·0847 per year. Hence the total shifting of the solstices becomes till 1938 A.D. = 22° 31′ 27″·54. Thus what was 270° of the longitude of the sun, should now become 291° 31′ nearly—a longitude which the sun now has about the 13th of January. On looking up some of the recent calendars we find that:—

(*a*) In the year 1922, there was a full-moon on Jan. 13.
(*b*) ,, ,, ,, 1937, ,, ,, a new-moon on Jan. 12.

We apply the elapsed years 1619 (sidereal) backward to Jan. 12, 1937 A.D., and arrive at the date:—

Dec. 20, 317 A.D., on which, at G.M.N., or Ujjayīnī M.T. 5-4 p.m.,

Mean Sun	= 269° 5′ 11″·26,	Hence $2e$	= 119′·5016,
,, Moon	= 272° 39′ 40″·40,	$\frac{5}{4}e^2$	= 1′·2981,
Lunar Perigee	= 39° 50′ 37″·25,	Appt. Sun	= 269°37′.
A. Node	= 257° 44′ 29°·88,	,, Moon	= 268°52′ nearly.
Sun's Apogee	= 74° 7′ 25°·16,		
,, Eccentricity	= ·0173808.		

The moon overtook the sun in about 1½ hours and the sun reached the winter solstice in about 9 hours. Hence Dec. 20, 317 A.D., was a new-moon day and also the day of winter solstice

according to the ordinary mode of Indian reckoning. As this day was similar to Jan. 12, 1937 A.D., *viz.*, lunar *Agrahāyaṇa* ended, it appears that the Gupta era was started from about the 21st Dec., 318 A.D., and this was the 12th day of lunar *Pauṣa.* It must be remembered in this connection, that the distinguishing character of the lunar *Agrahāyaṇa*, with which the year ended at the end of a correct luni-solar cycle, was that the last quarter of the moon was very nearly conjoined with *Citrā* (*Spica* or *α Virginis*).[1] In our opinion this character of the month was used for the intercalation of a lunar month at the end of a correct luni-solar cycle. We now proceed to examine the dates given in the Gupta Inscriptions as collected together by Dr. Fleet in his great book on the subject.

I. The First Instance of Gupta Inscription Date

शते पञ्चषष्ट्यधिके (१६५) वर्षाणाम् भूपतौ च बुधगुप्ते आषाढ़ मास शुक्लद्वादश्यां सुरगुरोर्दिवसे ।[2]

The inscription says that the 12th *tithi* of the light half of lunar *Āṣāḍha* of the Gupta year 165 fell on a Thursday. We examine this by both the modern and the *Siddhāntic* methods.

(A) By the Modern Method.

The year 165 of the Gupta kings is similar to the year 1924 A.D. The elapsed years till this date=1440 sidereal years= 525969 days. We increase the number of days by 1 and divide it by 7 ; the remainder is 4, which shows that the inscription statement of Thursday agrees with the Sunday of July 13, 1924 A.D.

We next apply 525969 days backward to July 13, 1924, and arrive at the date June 21, 484 A.D., the date of the inscription.

This date was 14·15 Julian centuries + 181·25 days before Jan. 1, 1900 A.D. Hence—

On June 21, 484 A.D., at G.M.N.,

Mean Sun	$= 91^\circ\ 12'\ 50''\cdot64$,	Hence—
,, Moon	$=235^\circ\ 7'\ 53''\cdot42$,	$2e=119'\cdot0564$.
Lunar Perigee	$=335^\circ\ 23'\ 2''\cdot80$,	$\frac{5}{4}e^2=1'\cdot290$.
A. Node	$=277^\circ\ 14'\ 51''\cdot51$,	
Sun's Apogee	$= 76^\circ\ 14'\ 32''$,	
,, Eccentricity	$=\cdot0173175$.	

[1] *Cf.* the longitude of the moon on Jan. 4, 1937 A.D , at L. Q. with that of *α Virginis*.

[2] Fleet's—Gupta Inscriptions, page 80, Eran Inscription.

From these we readily find the same mean places at the preceding Ujjayinī mean midnight. Hence—

On June 20, 484 A.D., at Ujjayinī mean midnight,

Mean Sun	$= 90° 30' 47''.38$,	Appt. Sun $= 90° 2'$,
,, Moon	$= 225° 45' 41''.78$,	,, Moon $= 219° 47'$ nearly.
Lunar Perigee	$= 335° 18' 17.61$,	
A. Node	$= 277° 17' 7''.08$.	

Thus at the Ujjayinī mean midnight of the day before (Wednesday), the 11th *tithi* was current, and next day, *Thursday*, had at sun rise the 12th *tithi* of the lunar month of *Āṣāḍha*.

(B) According to the method of the *Khaṇḍakhādyaka* of Brahmagupta, the *Kali ahargaṇa* on this Wednesday at the Ujjayinī mean midnight was $= 1309545$. Hence—

Mean Sun	$= 91° 3' 4''$,
,, Moon	$= 226° 23' 17''$,
Lunar Perigee	$= 335° 42' 56''$,
A. Node	$= 277° 35' 17''$.

The above two sets of the mean elements for the same instant are in fair agreement. *Hence the date of the inscription is Thursday, June 21, 484 A.D., and the Zero year of the Gupta era is thus 319 A.D. We are here in agreement with Dīkṣita's finding.*

II. The Second Instance of Gupta Inscription Date

श्रीविश्वनाथ प्रतिवद्ध नोजनानां वोधक रसुल महम्मद संवत् ६६२ तथा श्रीनृप विक्रम संवत् १३२० तथा श्रीमद्द वलभी संवत् ९४५ आषाढ़ वदि १३ रवौ अद्य इह ।[1]

Here the *Hijrī* year 662 shows the Vikrama *Saṁvat* is expressed in elapsed years as 1320 ; and as it is now reckoned it should be 1321. The Valabhi *Saṁvat* 945 is the same as the Gupta *Saṁvat* 945, in which the 13th *tithi* of the dark half of *Jyaiṣṭha* fell on a Sunday.

Now the mean *Khaṇḍakhādyaka ahargaṇa*

$$= 218878$$

from which we deduct $\underline{\quad 30}$

$$211848,$$

which we accept as the correct *ahargaṇa* and is exactly divisible

1 Fleet—Gupta Inscriptions, page 84, Veraval Inscription.

by 7, and which was true for Saturday of *Āṣāḍha vadi* 12 of the Gupta era 945. The English date for this Saturday was May 25, 1264 A.D. On the next day, Sunday, the date was, May 26, 1264 A.D., the date of the inscription.

From the above apparent *ahargaṇa* for May, 25, 1264 A.D., which was a Saturday, at the Ujjayinī mean midnight, we have

Mean Sun = $1^s\ 27°\ 42'\ 48''$,

,, Moon = $0^s\ 27°\ 31'\ 40''$,

Lunar Apogee = $6^s\ 20°\ 29'\ 1''$ (with Lalla's correction)

A. Node = $9^s\ 29°\ 53'\ 4''$ (Do. Do. Do)

Hence, Appt. Sun = $1^s\ 28°\ 21'\ 57''$,

,, Moon = $0^s\ 28°\ 8'\ 44''$,

∴ Moon − Sun = $10^s 29°\ 46'\ 47''$

= 27 *tithis* + $5°\ 46'\ 47''$.

Thus at the midnight (U.M.T.) of the Saturday ended, about 11 hrs. of the 13th *tithi* of the dark half of *Jyaiṣṭha* were over and 13 hrs. nearly of it remained. Thus the current *tithi* of the next morning of Sunday was also the 13th of the dark half of *Jyaiṣṭha* which is called *Āṣāḍha vadi* 13.

In the present case the Valabhi or Gupta year 945=1264 A.D. Hence also the Gupta era began from 319 A.D., and we are in agreement with Dīkṣita.

III. The Third Instance of Gupta Inscription Date

९२७ वर्षे फाल्गुन सुदि २ सोम । [1]

It is here stated that in the Gupta or Valabhī year 927, the 2nd *tithi* of the light half of *Phālguna* fell on a Monday. The English date becomes 1246 A.D., Feb. 19. Saka year was 1167 years + 11 months + 2 *tithis*, the Gupta year being taken to have been reckoned from the light half of lunar *Pauṣa*.

[1] Fleet's Gupta Inscriptions, page 90, Veraval Inscription.

On June 16, 63 B.C., at G. M. N., we had—

Mean Sun = 81° 38′ 59″·72,	Hence—
,, Moon = 80° 20′ 8″·16,	Appt. Moon = 80° 45′
Lunar Perigee = 76° 0′ 2″·58,	,, Sun = 81° 11′
Sun's Apogee = 67° 39′,	Jupiter as corrected by the equation of apsis,
Mean Jupiter = 80° 52′ 26″·87,	= 85° 54′ 54″.
Jupiter's Perihelion = 341° 34′ 32″,	
,, Eccentricity = ·0443845.	*v Cancri* = 97° 5′.

Jupiter had set already and the new-moon happened in the *nakṣatra Punarvasu* ; the Jovial year begun was thus *Pauṣa* or *Mahāpauṣa*. The longitude of the oldest first point of the Hindu sphere was about, −6° in this year and consequently the longitude of the first point of the *Puṣyā* division was = 87°20′. Jupiter was very near to this point. It may thus be inferred that the signal from Jupiter's position as to the beginning of the *Kṛtayuga* was taken to occur on this date, *viz.*, June 16, 63 B.C.

Again on July 16, 63 B.C., at G.M.T. 0 hr., or exactly one synodic month later—

Mean Sun = 110° 43′ 37″·39,	Hence—
,, Moon = 109° 2′ 21″·48,	Appt. Moon = 110° 57′,
Lunar Perigee = 79° 17′ 13″·71,	,, Sun = 109° 23′,
Mean Jupiter = 83° 19′ 35″·21.	Jupiter as corrected by the eqn. of apsis = 88° 19′.

On this day also the sun, moon, Jupiter and the *nakṣatra Puṣyā* were in the same cluster. This day also most probably afforded another signal for the coming of the *Kṛtayuga*. Jupiter had become heliacally visible about 10 days before.

If we go forward by 12 lunations from the above date, we arrive at July 5, 62 B.C., on which, at G.M.N.,

Mean Sun = 100° 8′ 20″·52,
,, Moon = 100° 4′ 19″·20,
,, Jupiter = 112° 47′ 44″·98.
δ *Cancri* = 100° 4′ nearly.

Here was another combination of the planets, which might have persuaded men that the *Kṛtayuga* had begun.

On the whole it is thus established that both the luni-solar, and the luni-solar-Jovial-stellar combined signals for the beginning of the *Kṛtayuga*, could be observed and estimated in the year 63 B.C. In this year the sun's reaching the winter solstice happened on Dec. 24, and the full-moon

day of *Pauṣa* was the day following it. The actual starting of the *Kṛta, Mālava* or the *Saṁvat* era was made 5 years later from the full-moon day of about the 28th Dec., 58 B.C. The *Saṁvat* year 1 was thus almost the same as 57 B.C., and that the number of the *Saṁvat* era represents the current year as in the Christian era. Further the lunar months here are full-moon ending as originally in the Śaka era, as we have seen in the preceding chapters. The year was reckoned from the full-moon day of *Pauṣa*. In 499 A.D. or some years later than this date, the *Caitra-Śuklādi* reckoning was followed according to the rule of Āryabhaṭa. But in the *Saṁvat* era, we are told that the lunar months are still reckoned as full-moon ending, which is now a case of a queer combination of opposites. We next turn to solve the last problem from the epigraphic source in relation to this era.

Mālava Saṁvat 529, the Second Day of the Light Half of Phālguna and the Beginning of Spring

In Fleet's Gupta Inscriptions, Plate No. 18, it is stated that spring had set in on the second day of the light half of *Phālguna* of the Mālava *Saṁvat* 529 or 473 A.D. Now the year in our time which was similar to 529 of the Malava era was 1932 A.D., and the date, to March 9, 1932. Elapsed years till this date was=1459 sidereal years=18046 lunations=5320909 days. These days are applied backward to March 9, 1932 A.D., and we arrive at the date:—

Feb. 15, 473 A.D., on which, at the Ujjayinī mean midnight,

Mean Sun	=326° 58′ 38″·09,	Hence—
,, Moon	=355° 57′ 22″·72,	Appt. Sun=328° 48′ 24″,
Lunar Perigee	=233° 43′ 28″·68,	,, Moon=360° 20′
Sun's Apogee	= 76° 46′ 14″·81,	nearly.
,, Eccentricity	=·017323.	

Now the Indian spring begins, when the sun's longitude becomes 330°, which happened about 30 hours later, *i.e.*, on the 17th Feb., 473 A.D. The local conditions probably brought in spring earlier.

Again 2·5 days before Feb. 15, 473 A.D., at Ujjayinī mean midnight, or on the 13th February, 473 A.D.. at Ujjayinī mean midday :—

Mean Sun	=324° 30′ 47″·25,
Mean Moon	=323° 0′ 55″·12,
Lunar Perigee	=233° 26′ 46″·04.

It appears that the new-moon had happened about 3½ hrs. before, and the first visibility of the crescent took place on the evening of the next day, the 14th Feb. Thus Feb. 15 was the second day of the month, as stated in the inscription.

We now proceed to consider why there has been an error in estimating the beginning of spring, which according to an old rule should come 60 days after the winter solstice day. We find that 60 days before this date, *viz.*, Feb. 15, or, on :—

Dec. 17, 472 A.D., at Ujjayini mean midday,

Mean Sun	=267° 20′ 37″,
,, Moon	=284° 48′ 4″,
Lunar Perigee	=226° 59′ 5″.

The estimated winter solstice day was thus premature by about two days. On this day, the first visibility of the crescent took place in the evening. Hence the second day of the light half of *Phālguna* was the estimated beginning of spring, *i.e.*, 60 days later. The new-moon happened on the 16th December and the real winter solstice day was the 19th December.

This inscription shows that the Gupta era cannot be identified with the *Saṁvat* era. The point that why or how the Mālava era came to be called Vikrama *Saṁvat* cannot be answered from any astronomical data,

Note.—We have here tried to interpret the astronomical statement of the Mandasor stone inscription of Kumara Gupta and Bandhuvarman. The date of the inscription found here as Feb. 15, 473 A.D., was that of the thorough repair and decoration of the sun temple at Mandasor (24°3′N and 75°8′E). The inscription says that spring has set in.

CHAPTER XXV

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Mean Sun = $1^s\ 27°\ 42'\ 48''$,
,, Moon = $0^s\ 27°\ 31'\ 40''$,
Lunar Apogee = $6^s\ 20°\ 29'\ 1''$ (with Lalla's correction)
A. Node = $9^s\ 29°\ 53'\ 4''$ (Do. Do. Do)
Hence, Appt. Sun = $1^s\ 28°\ 21'\ 57''$,
,, Moon = $0^s\ 28°\ 8'\ 44''$,
∴ Moon − Sun = $10^s 29°\ 46'\ 47''$
= 27 *tithis* + $5°\ 46'\ 47''$.

Thus at the midnight (U.M.T.) of the Saturday ended, about 11 hrs. of the 13th *tithi* of the dark half of *Jyaiṣṭha* were over and 13 hrs. nearly of it remained. Thus the current *tithi* of the next morning of Sunday was also the 13th of the dark half of *Jyaiṣṭha* which is called *Āṣāḍha vadi* 13.

In the present case the Valabhi or Gupta year 945=1264 A.D. Hence also the Gupta era began from 319 A.D., and we are in agreement with Dīkṣita.

III. The Third Instance of Gupta Inscription Date

९२७ वर्षे फाल्गुन सुदि २ सोम । [1]

It is here stated that in the Gupta or Valabhī year 927, the 2nd *tithi* of the light half of *Phālguna* fell on a Monday. The English date becomes 1246 A.D., Feb. 19. Saka year was 1167 years + 11 months + 2 *tithis*, the Gupta year being taken to have been reckoned from the light half of lunar *Pauṣa*.

[1] Fleet's Gupta Inscriptions, page 90, Veraval Inscription.

The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

Mean Sun = $10^s\ 24°\ 43'\ 44''$,
,, Moon = $11^s\ 24°\ 26'\ 37''$,
Lunar Apogee = $6^s\ 3°\ 20'\ 53''$,
A. Node = $2^s\ 1°\ 59'\ 40''$.

Hence on the same date at 6 a.m., Ujjayinī M.T.,

Mean Sun = $10^s\ 23°\ 59'\ 23''$,	Thus—
Sun's Apogee = $2^s\ 17°\ 0'\ 0''$,	Appt. Sun = $325°\ 59'\ 2''$,
Mean Moon = $11^s\ 14°\ 33'\ 41''$,	,, Moon = $342°\ 56'\ 51''$.
Lunar Apogee = $6^s\ 3°\ 15'\ 52''$	

$$\therefore \text{Moon} - \text{Sun} = 16°\ 57'\ 25'' = 1\ tithi + 4°\ 57'\ 25''.$$

On this Monday, the *tithi* was the second of the light half of unar *Phālguna,* while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna.* We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa,* the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta, the total *Kali-solar* days up to 570 of Śaka elapsed + 9 months = 1349910, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

[1] Fleet—Gupta Inscriptions, page 92, the Kaira (22°45′N, 72°45′E) Grant.

method of the *Siddhāntas*, there can be no intercalary month in the solar month of *Agrahāyaṇa*, of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

On Dec. 20 of the year 317 A.D., there was a new-moon with which the lunar *Agrahāyaṇa* ended and the sun turned north. The character of this lunar *Agrahāyaṇa* was that the last quarter was conjoined with *Citrā* or α *Virginis*. The Gupta era was started one year later than this date, from the 20th Dec., 318 A.D. The year 330 of the Gupta era was thus the year which ended about Dec. 20, 648 A.D. and the number of years elapsed was $=331=160\times2+11$.

Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or α *Virginis*, in the latter part of the night.

On this day, at G. M. N., we had—

Mean Sun	$=264°\ 57'\ 0''\cdot47$,	Hence—
,, Moon	$=180°\ 14'\ 22''\cdot10$,	Apparent Sun $=265°\ 8'$.
Lunar Perigee	$=188°\ 32'\ 34''\cdot17$,	,, Moon $=179°\ 10'$,
Sun's Apogee	$=\ 79°\ 46'\ 40''\cdot79$.	Long. of α *Virginis* $=185°$ nearly
$2e=118'\cdot7$, $\frac{5}{4}e^2=1'\cdot398$.		

From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa*, was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa* $=29da.\ 30n.\ 24v.\ 2^{III}\ 33^{IV}$ (Burgess—*S. Siddhānta*, xiv, 3).

Length of Lunar month $=29da.\ 31n.\ 50v.\ 6^{III}\ 53^{IV}$ (acc. to the *Khaṇḍakhādyaka*).

Planet	Position in Nakṣatra in Ref. I	Position in N. kṣatra in Ref. II	
Saturn	Rohiṇī	P. Phalgunī or Viśākhās	
Mars	Anurādhā	Maghā or Rohiṇī	
Sun	Jyeṣṭhā or Kṛttikā	Rohiṇī or Dhaniṣṭhā	(*i.e.*, opposite to Maghā)
Moon	...	Rohiṇī	
Unnamed Planet	Citrā	Bet. Citrā & Svātī	
A-Node	Near to *Jyeṣṭhā*	...	
Venus	...	P. Bhādrapada or Citrā	
Jupiter	...	Śravaṇā or Viśākhā	

All this is hopelessly inconsistent astrological effusions of evil omens fit for Mother Goose's Tales only. Still something of chronology of the Bhārata battle was attempted by late Mr. Lele from them for which the reader in referred to Dīkṣita's **भारतीय ज्योतिःशास्त्र,** pp. 119-20 (1st edn.); the date arrived at by him was 2127 years before 3102 B.C.—a most fantastic result! His finding of the positions of planets does not also agree with the abovementioned positions indicated in the *Mahābhārata* as explained already.

We again have the two statements:—

(*a*) राहुरग्रसदादित्यमपर्वणि विशाम्पते ॥१९॥

M.Bh., *Sabhā*, Ch. 79.

(*b*) राहुश्चाग्रसदादित्यमपर्वणि विशाम्पते ॥१०॥

M.Bh., *Śalya*, Ch. 59.

i.e., "Rāhu (also) eclipsed the sun, O king, when it was not a new-moon."

These statements are also mere poetic effusions. In *Bhīṣma parva*, Chapter III, we have another statement which says:—

चन्द्रसूर्यावुभौ ग्रस्तावेकमासीं त्रयोदशीम् ॥३२॥

"The moon and the sun were eclipsed in one month on the 13th day of either half."

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun	=234° 22′ 29″·34,
Sun's Apogee	= 83° 9′ 18″·32,
Mean Moon	=231° 7′ 21″·80,
D. Node	=246° 7′ 31″·10,
Lunar Perigee	=162° 10′ 10″·68.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era+8 lunations=87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become :—

Mean Sun	=228° 18′ 5″,
,, Moon	=224° 27′ 36″,
D. Node	=239° 44′ 56″,
Lunar Perigee	=155° 59′ 47″.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā-vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era	=475 A.D.
Julian days on Jan. 1, 475 A.D.	=1894552, and
,, ,, ,, ,, ,, 1900 A.D.	=2415021.

The difference is 520469 days which comprise 14·24 Julian centuries+253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11-4 a.m. Ujjayinī M.T.,

Mean Jupiter $= 170° \ 54' \ 6''.57$,

Mean Sun $= 269° \ 47' \ 11''.66$.

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later, *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

Mean Jupiter $= 194° \ 55' \ 34''{\cdot}42$,

Mean Sun $= 194° \ 38' \ 19''{\cdot}15$.

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively $-2° \ 6' \ 4''{\cdot}01$ and $-1° \ 45' \ 2''{\cdot}70$. Hence their apparent places became as follows:—

Appt. Jupiter $= 192° \ 49' \ 30''{\cdot}41$,

,, Sun $= 192° \ 53' \ 16''{\cdot}45$.

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

Appt. Sun $= 208° \ 45'$, and

,, Jupiter $= 196° \ 20'$ nearly.

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter.

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम् । [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941 − 482 = 1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

$$\text{Mean Jupiter} = 29^\circ\ 58'\ 8''\cdot24,$$
$$\text{,, Sun} = 347^\circ\ 12'\ 47''\cdot11.$$

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

$$\text{Mean Jupiter} = 32^\circ\ 27'\ 46''\cdot22,$$
$$\text{,, Sun} = 16^\circ\ 46'\ 57''\cdot02 \text{ at G.M.N.}$$

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇī*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D , which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

[1] Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or *α Virginis*, on the 20th Jan. before sunrise. Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्बत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A.D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years.

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date. Feb. 12, 510 A.D.

[1] Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 133·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days=5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule:

युगवर्षं मास दिवसाः समंप्रवृत्तास्ते चैत्रशुक्लादेः ।

Kālakriyā, 11.

The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

$$\begin{aligned} \text{Mean Sun} &= 10^s\ 24°\ 43'\ 44'', \\ ,,\ \text{Moon} &= 11^s\ 24°\ 26'\ 37'', \\ \text{Lunar Apogee} &= 6^s\ 3°\ 20'\ 53'', \\ \text{A. Node} &= 2^s\ 1°\ 59'\ 40''. \end{aligned}$$

Hence on the same date at 6 a.m., Ujjayinī M.T.,

Mean Sun = 10^s 23° 59′ 23″,	Thus—
Sun's Apogee = 2^s 17° 0′ 0″,	Appt. Sun = 325° 59′ 2″,
Mean Moon = 11^s 14° 33′ 41″,	,, Moon = 342 56′ 51″.
Lunar Apogee = 6^s 3° 15′ 52″	

$$\begin{aligned} \therefore\ \text{Moon}-\text{Sun} &= 16°\ 57'\ 25'' \\ &= 1\ tithi + 4°\ 57'\ 25''. \end{aligned}$$

On this Monday, the *tithi* was the second of the light half of unar *Phālguna,* while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna*. We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत्त द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa*, the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta the total *Kali-solar* days up to 570 of Saka elapsed + 9 months = 1349910, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

[1] Fleet—Gupta Inscriptions, page 92, the Kaira (22°45′N, 72°45′E) Grant.

method of the *Siddhāntas*, there can be no intercalary month in the solar month of *Agrahāyaṇa*, of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

On Dec. 20 of the year 317 A.D., there was a new-moon with which the lunar *Agrahāyaṇa* ended and the sun turned north. The character of this lunar *Agrahāyaṇa* was that the last quarter was conjoined with *Citrā* or α *Virginis*. The Gupta era was started one year later than this date, from the 20th Dec., 318 A.D. The year 330 of the Gupta era was thus the year which ended about Dec. 20, 648 A.D. and the number of years elapsed was $=331=160\times 2+11$.

Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or α *Virginis*, in the latter part of the night.

On this day, at G. M. N., we had—

Mean Sun	$=264^\circ\ 57'\ 0''{\cdot}47$,	Hence—	
,, Moon	$=180^\circ\ 14'\ 22''{\cdot}10$,	Apparent Sun	$=265^\circ\ 8'$.
Lunar Perigee	$=188^\circ\ 32'\ 34''{\cdot}17$,	,, Moon	$=179^\circ\ 10'$,
Sun's Apogee	$=79^\circ\ 46'\ 40''\ 79$.	Long. of α *Virginis*	$=185^\circ$ nearly
$2e=118'{\cdot}7$, $\frac{5}{4}e^2=1'{\cdot}398$.			

From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa*, was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa* = 29*da.* 30*n.* 24v. 2^III 33^IV (Burgess—*S. Siddhānta*, xiv, 3).

Length of Lunar month = 29*da.* 31*n.* 50v. 6^III 53^IV (acc. to the *Khaṇḍakhādyaka*).

648 A.D., the year 330 of the Gupta era ended. *It must be admitted that the inscription as it has been read or as it was executed was slightly defective. In this case also Āryabhaṭa I's Caitra-Śuklādi reckoning is not followed.*

Here *330 of the Gupta era = 649 A.D.*

∴ *Zero of the ,, ,, = 319 A.D.*

V. Morvi Copper Plate Inscription

पञ्चाशीत्यायुतेऽतीते समानां शतपञ्चके ।
गौप्ते ददावदोनृपः सोपरागेऽर्कमण्डले ॥
संवत् ५८५ फाल्गुन सुदि ५ ।

This inscription says that on the day of the 5th *tithi* of the light half of lunar *Phālguna* of the Gupta year 585, the king of the place Morvi (22° 49′ N and 70° 53′ E) made a gift at the time of a solar eclipse, which happened some time before this date, on which the deed of gift, *viz.*, the copper plate in question, was executed.

To find the date of this copper plate, had been a pit-fall for Dr. Fleet, who mistook that the solar eclipse in question happened on the 7th May, 905 A.D. Now the year 585 of the Gupta should be 904 A.D. and the date of execution of the plate should be Feb. 20, 904 A.D. We looked for the solar eclipse, two lunations + 5 days before and 8 lunations + 5 days before this date. Although there happened the two solar eclipses at these times, they were not visible in India.

We find, however, that here the Gupta year is reckoned not from the light half of *Pauṣa*, but from the light half of *Caitra* according to Āryabhaṭa I's rule. Here the year 585 of the Gupta era = 826 of the *Caitra-Śuklādi* Śaka era = 904-905 A.D., or the Zero year of the Gupta era = 319-20 A.D. the date of the inscription corresponds to March 3, 1941 A.D., and the elapsed years till this date = 1036 years = 12814 lunations = 378405 days. The date of the copper plate works out to have been *Feb. 12, 905 A.D.* The eclipse referred to in the inscription happened on

[1] Finally accepted by Fleet—Indian Antiquary, Nov., 1891, page 382. S. B. Dīkṣita did actually find it.

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun	$=234° 22' 29''{\cdot}34$,
Sun's Apogee	$= 83° 9' 18''{\cdot}32$,
Mean Moon	$=231° 7' 21''{\cdot}80$,
D. Node	$=246° 7' 31''{\cdot}10$,
Lunar Perigee	$=162° 10' 10''{\cdot}68$.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era + 8 lunations = 87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become:—

Mean Sun	$=228° 18' 5''$,
,, Moon	$=224° 27' 36''$,
D. Node	$=239° 44' 56''$,
Lunar Perigee	$=155° 59' 47''$.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era	= 475 A.D.
Julian days on Jan. 1, 475 A.D.	= 1894552, and
,, ,, ,, ,, ,, 1900 A.D.	= 2415021.

The difference is 520469 days which comprise 14·24 Julian centuries + 253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11-4 a.m. Ujjayinī M.T.,

$$\text{Mean Jupiter} = 170^\circ\ 54'\ 6''.57,$$
$$\text{Mean Sun} = 269^\circ\ 47'\ 11''.66.$$

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later. *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

$$\text{Mean Jupiter} = 194^\circ\ 55'\ 34''{\cdot}42,$$
$$\text{Mean Sun} = 194^\circ\ 38'\ 19''{\cdot}15.$$

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively $-2^\circ\ 6'\ 4''{\cdot}01$ and $-1^\circ\ 45'\ 2''{\cdot}70$. Hence their apparent places became as follows:—

$$\text{Appt. Jupiter} = 192^\circ\ 49'\ 30''{\cdot}41,$$
$$\text{,, Sun} = 192^\circ\ 53'\ 16''{\cdot}45.$$

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

$$\text{Appt. Sun} = 208^\circ\ 45', \text{ and}$$
$$\text{,, Jupiter} = 196^\circ\ 20' \text{ nearly.}$$

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter.

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम् । [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941 − 482 = 1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

Mean Jupiter = 29° 58′ 8″·24,
,, Sun = 347° 12′ 47″·11.

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

Mean Jupiter = 32° 27′ 46″·22,
,, Sun = 16° 46′ 57″·02 at G.M.N.

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇī*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D, which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

[1] Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or *α Virginis*, on the 20th Jan. before sunrise Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्बत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A.D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years.

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date. Feb. 12, 510 A.D.

[1] Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 183·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days=5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule:

युगवर्ष मास दिवसाः समंप्रवृत्तास्ते चैत्रशुक्लादेः ।

Kālakriyā, 11.

The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

$$\begin{aligned} \text{Mean Sun} &= 10^s\ 24^\circ\ 43'\ 44'', \\ \text{,, Moon} &= 11^s\ 24^\circ\ 26'\ 37'', \\ \text{Lunar Apogee} &= 6^s\ 3^\circ\ 20'\ 53'', \\ \text{A. Node} &= 2^s\ 1^\circ\ 59'\ 40''. \end{aligned}$$

Hence on the same date at 6 a.m., Ujjayinī M.T.,

$$\begin{aligned} \text{Mean Sun} &= 10^s\ 23^\circ\ 59'\ 23'', \\ \text{Sun's Apogee} &= 2^s\ 17^\circ\ 0'\ 0'', \\ \text{Mean Moon} &= 11^s\ 14^\circ\ 33'\ 41'', \\ \text{Lunar Apogee} &= 6^s\ 3^\circ\ 15'\ 52'' \end{aligned}$$

Thus—

$$\begin{aligned} \text{Appt. Sun} &= 325^\circ\ 59'\ 2'', \\ \text{,, Moon} &= 342^\circ\ 56'\ 51''. \end{aligned}$$

$$\begin{aligned} \therefore\ \text{Moon} - \text{Sun} &= 16^\circ\ 57'\ 25'' \\ &= 1\ tithi + 4^\circ\ 57'\ 25''. \end{aligned}$$

On this Monday, the *tithi* was the second of the light half of unar *Phālguna*, while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna*. We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa*, the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta the total *Kali-solar* days up to 570 of Śaka elapsed + 9 months = 1349910, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

[1] Fleet—Gupta Inscriptions, page 92, the Kaira (22°45′N, 72°45′E) Grant.

method of the *Siddhāntas* there can be no intercalary month in the solar month of *Agrahāyaṇa,* of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

On Dec. 20 of the year 317 A.D., there was a new-moon with which the lunar *Agrahāyaṇa* ended and the sun turned north. The character of this lunar *Agrahāyaṇa* was that the last quarter was conjoined with *Citrā* or α *Virginis.* The Gupta era was started one year later than this date, from the 20th Dec., 318 A.D. The year 330 of the Gupta era was thus the year which ended about Dec. 20, 648 A.D. and the number of years elapsed was $=331=160\times 2+11$.

Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or α *Virginis,* in the latter part of the night.

On this day, at G. M. N., we had—

		Hence—
Mean Sun	$=264°\ 57'\ 0''{\cdot}47$,	Apparent Sun $=265°\ 8'$.
,, Moon	$=180°\ 14'\ 22''{\cdot}10$,	,, Moon $=179°\ 10'$,
Lunar Perigee	$=188°\ 32'\ 34''{\cdot}17$,	Long. of α *Virginis* $=185°$ nearly
Sun's Apogee	$=79°\ 46'\ 40''{\cdot}79$.	
$2e=118'{\cdot}7$, $\frac{5}{4}e^2=1'{\cdot}398$.		

From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa,* was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa*=29*da.* 30*n.* 24v. $2^{\text{III}}\ 33^{\text{IV}}$ (Burgess—*S. Siddhānta,* xiv, 3).

Length of Lunar month =29*da.* 31*n* 50v. $6^{\text{III}}\ 53^{\text{IV}}$ (acc. to the *Khaṇḍakhādyaka*).

648 A.D., the year 330 of the Gupta era ended. *It must be admitted that the inscription as it has been read or as it was executed was slightly defective. In this case also Āryabhaṭa I's Caitra-Śuklādi reckoning is not followed.*

Here *330 of the Gupta era = 649 A.D.*

∴ *Zero of the ,, ,, = 319 A.D.*

V. Morvi Copper Plate Inscription

पञ्चाशीत्यायुतेऽतीते समानां शतपञ्चके ।
गौप्ते ददावदोनृपः सोपरागेऽर्कमण्डले ॥
संवत् ५८५ फाल्गुन सुदि ५ ।

This inscription says that on the day of the 5th *tithi* of the light half of lunar *Phālguna* of the Gupta year 585, the king of the place Morvi (22° 49′ N and 70° 53′ E) made a gift at the time of a solar eclipse, which happened some time before this date, on which the deed of gift, *viz.*, the copper plate in question, was executed.

To find the date of this copper plate, had been a pit-fall for Dr. Fleet, who mistook that the solar eclipse in question happened on the 7th May, 905 A.D. Now the year 585 of the Gupta should be 904 A.D. and the date of execution of the plate should be Feb. 20, 904 A.D. We looked for the solar eclipse, two lunations + 5 days before and 8 lunations + 5 days before this date. Although there happened the two solar eclipses at these times, they were not visible in India.

We find, however, that here the Gupta year is reckoned not from the light half of *Pauṣa*, but from the light half of *Caitra* according to Āryabhaṭa I's rule. Here the year 585 of the Gupta era = 826 of the *Caitra-Śuklādi* Śaka era = 904-905 A.D., or the Zero year of the Gupta era = 319-20 A.D. the date of the inscription corresponds to March 3, 1941 A.D., and the elapsed years till this date = 1036 years = 12814 lunations = 378405 days. The date of the copper plate works out to have been *Feb. 12, 905 A.D.* The eclipse referred to in the inscription happened on

1 Finally accepted by Fleet—Indian Antiquary, Nov., 1891, page 382. S. B. Dikṣita did actually find it.

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun	=234° 22′ 29″·34,
Sun's Apogee	= 83° 9′ 18″·32,
Mean Moon	=231° 7′ 21″·80,
D. Node	=246° 7′ 31″·10,
Lunar Perigee	=162° 10′ 10″·68.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era+8 lunations=87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become:—

Mean Sun	=228° 18′ 5″,
,, Moon	=224° 27′ 36″,
D. Node	=239° 44′ 56″,
Lunar Perigee	=155° 59′ 47″.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā-vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era	=475 A.D.
Julian days on Jan. 1, 475 A.D.	=1894552, and
,, ,, ,, ,, ,, 1900 A.D.	=2415021.

The difference is 520469 days which comprise 14·24 Julian centuries+253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11·4 a.m. Ujjayinī M.T.,

Mean Jupiter $=170^\circ\ 54'\ 6''.57$,

Mean Sun $=269^\circ\ 47'\ 11''.66$.

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later, *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

Mean Jupiter $= 194^\circ\ 55'\ 34''\cdot42$,

Mean Sun $= 194^\circ\ 38'\ 19''\cdot15$.

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively $-2^\circ\ 6'\ 4''\cdot01$ and $-1^\circ\ 45'\ 2''\cdot70$. Hence their apparent places became as follows:—

Appt. Jupiter $= 192^\circ\ 49'\ 30''\cdot41$,

,, Sun $= 192^\circ\ 53'\ 16''\cdot45$.

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

Appt. Sun $=208^\circ\ 45'$, and

,, Jupiter $=196^\circ\ 20'$ nearly.

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter.

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम्। [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941 − 482 = 1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

Mean Jupiter = 29° 58′ 8″·24,
,, Sun = 347° 12′ 47″·11.

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

Mean Jupiter = 32° 27′ 46″·22,
,, Sun = 16° 46′ 57″·02 at G.M.N.

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇī*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D, which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

1. Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or α *Virginis*, on the 20th Jan. before sunrise. Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्बत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A.D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date. Feb. 12, 510 A.D.

[1] Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 133·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days=5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule:

युगवर्ष मास दिवसाः समंप्रवृत्तास्ते चैत्रशुक्लादेः ।

Kālakriyā, 11.

The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

Mean Sun = $10^s\ 24°\ 43'\ 44''$,
,, Moon = $11^s\ 24°\ 26'\ 37''$,
Lunar Apogee = $6^s\ 3°\ 20'\ 53''$,
A. Node = $2^s\ 1°\ 59'\ 40''$.

Hence on the same date at 6 a.m., Ujjayinī M.T.,

Mean Sun = $10^s\ 23°\ 59'\ 23''$,
Sun's Apogee = $2^s\ 17°\ 0'\ 0''$,
Mean Moon = $11^s\ 14°\ 33'\ 41''$,
Lunar Apogee = $6^s\ 3°\ 15'\ 52''$

Thus—
Appt. Sun = $325°\ 59'\ 2''$,
,, Moon = $342°\ 56'\ 51''$.

∴ Moon − Sun = $16°\ 57'\ 25''$
= 1 *tithi* + $4°\ 57'\ 25''$.

On this Monday, the *tithi* was the second of the light half of unar *Phālguna*, while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna*. We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa*, the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta the total *Kali-solar* days up to 570 of Śaka elapsed + 9 months = 1349910, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

[1] Fleet—Gupta Inscriptions, page 92, the Kaira (22°45′N, 72°45′E) Grant.

method of the *Siddhāntas*. there can be no intercalary month in the solar month of *Agrahāyaṇa*, of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

On Dec. 20 of the year 317 A.D., there was a new-moon with which the lunar *Agrahāyaṇa* ended and the sun turned north. The character of this lunar *Agrahāyaṇa* was that the last quarter was conjoined with *Citrā* or α *Virginis*. The Gupta era was started one year later than this date, from the 20th Dec., 318 A.D. The year 330 of the Gupta era was thus the year which ended about Dec. 20, 648 A.D. and the number of years elapsed was $=331=160\times 2+11$.

Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or α *Virginis*, in the latter part of the night.

On this day, at G. M. N., we had—

Mean Sun $=264°\ 57'\ 0''{\cdot}47$,	Hence—	
,, Moon $=180°\ 14'\ 22''{\cdot}10$,	Apparent	Sun $=265°\ 8'$.
Lunar Perigee $=188°\ 32'\ 34''{\cdot}17$,	,,	Moon $=179°\ 10'$,
Sun's Apogee $=79°\ 46'\ 40''{\cdot}79$.	Long. of α *Virginis*	$=185°$ nearly
$2e=118'{\cdot}7$, $\frac{5}{4}e^2=1'{\cdot}398$.		

From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa*, was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa* = 29*da*. 30*n*. 24v $2^{III}\ 33^{IV}$ (Burgess—*S. Siddhānta*, xiv, 3).

Length of Lunar month = 29*da*. 31*n*. 50v. $6^{III}\ 53^{IV}$ (acc. to the *Khaṇḍakhādyaka*).

648 A.D., the year 330 of the Gupta era ended. *It must be admitted that the inscription as it has been read or as it was executed was slightly defective. In this case also Āryabhaṭa I's Caitra-Śuklādi reckoning is not followed.*

Here *330 of the Gupta era = 649 A.D.*

∴ *Zero of the ,, ,, = 319 A.D.*

V. Morvi Copper Plate Inscription

पञ्चाशीत्यायुतेऽतीते समानां शतपञ्चके ।
गौप्ते ददावदोनृपः सोपरागेऽर्कमण्डले ॥
संवत् ५८५ फाल्गुन सुदि ५ ।

This inscription says that on the day of the 5th *tithi* of the light half of lunar *Phālguna* of the Gupta year 585, the king of the place Morvi (22° 49′ N and 70° 53′ E) made a gift at the time of a solar eclipse, which happened some time before this date, on which the deed of gift, *viz.*, the copper plate in question, was executed.

To find the date of this copper plate, had been a pit-fall for Dr. Fleet, who mistook that the solar eclipse in question happened on the 7th May, 905 A.D. Now the year 585 of the Gupta should be 904 A.D. and the date of execution of the plate should be Feb. 20, 904 A.D. We looked for the solar eclipse, two lunations + 5 days before and 8 lunations + 5 days before this date. Although there happened the two solar eclipses at these times, they were not visible in India.

We find, however, that here the Gupta year is reckoned not from the light half of *Pauṣa*, but from the light half of *Caitra* according to Āryabhaṭa I's rule. Here the year 585 of the Gupta era = 826 of the *Caitra-Śuklādi* Śaka era = 904-905 A.D., or the Zero year of the Gupta era = 319-20 A.D. the date of the inscription corresponds to March 3, 1941 A.D., and the elapsed years till this date = 1036 years = 12814 lunations = 378405 days. The date of the copper plate works out to have been *Feb. 12, 905 A.D.* The eclipse referred to in the inscription happened on

1 Finally accepted by Fleet—Indian Antiquary, Nov., 1891, page 382. S. B. Dīkṣita did actually find it.

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun	$=234° \ 22' \ 29''{\cdot}34$,
Sun's Apogee	$= \ 83° \ \ 9' \ 18''{\cdot}32$,
Mean Moon	$=231° \ \ 7' \ 21''{\cdot}80$,
D. Node	$=246° \ \ 7' \ 31''{\cdot}10$,
Lunar Perigee	$=162° \ 10' \ 10''{\cdot}68$.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era+8 lunations=87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become:—

Mean Sun	$=228° \ 18' \ \ 5''$,
,, Moon	$=224° \ 27' \ 36''$,
D. Node	$=239° \ 44' \ 56''$,
Lunar Perigee	$=155° \ 59' \ 47''$.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā-vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era	=475 A.D.
Julian days on Jan. 1, 475 A.D.	=1894552, and
,, ,, ,, ,, ,, 1900 A.D.	=2415021.

The difference is 520469 days which comprise 14·24 Julian centuries+253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11-4 a.m. Ujjayinī M.T.,

Mean Jupiter = 170° 54′ 6″.57,
Mean Sun = 269° 47′ 11″.66.

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later, *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

Mean Jupiter = 194° 55′ 34″·42,
Mean Sun = 194° 38′ 19″·15.

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively −2° 6′ 4″·01 and −1° 45′ 2″·70. Hence their apparent places became as follows:—

Appt. Jupiter = 192° 49′ 30″·41,
,, Sun = 192° 53′ 16″·45.

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

Appt. Sun = 208° 45′, and
,, Jupiter = 196° 20′ nearly.

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter..

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम् । [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941 − 482 = 1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

$$\text{Mean Jupiter} = 29^\circ\ 58'\ 8''\cdot 24,$$
$$\text{,, Sun} = 347^\circ\ 12'\ 47''\cdot 11.$$

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

$$\text{Mean Jupiter} = 32^\circ\ 27'\ 46''\cdot 22,$$
$$\text{,, Sun} = 16^\circ\ 46'\ 57''\cdot 02 \text{ at G.M.N.}$$

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇi*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D , which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

[1] . Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or α *Virginis*, on the 20th Jan. before sunrise Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्वत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date. Feb. 12, 510 A.D.

1 Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 133·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days=5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule :

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The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

$$\begin{aligned} \text{Mean Sun} &= 10^s\ 24^\circ\ 43'\ 44'', \\ \text{,, Moon} &= 11^s\ 24^\circ\ 26'\ 37'', \\ \text{Lunar Apogee} &= 6^s\ 3^\circ\ 20'\ 53'', \\ \text{A. Node} &= 2^s\ 1^\circ\ 59'\ 40''. \end{aligned}$$

Hence on the same date at 6 a.m., Ujjayinī M.T.,

Mean Sun $= 10^s\ 23^\circ\ 59'\ 23''$,	Thus—
Sun's Apogee $= 2^s\ 17^\circ\ 0'\ 0''$,	Appt. Sun $= 325^\circ\ 59'\ 2''$,
Mean Moon $= 11^s\ 14^\circ\ 33'\ 41''$,	,, Moon $= 342^\circ\ 56'\ 51''$.
Lunar Apogee $= 6^s\ 3^\circ\ 15'\ 52''$	

$$\begin{aligned} \therefore\ \text{Moon} - \text{Sun} &= 16^\circ\ 57'\ 25'' \\ &= 1\ \textit{tithi} + 4^\circ\ 57'\ 25''. \end{aligned}$$

On this Monday, the *tithi* was the second of the light half of unar *Phālguna*, while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna*. We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa*, the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta the total *Kali-solar* days up to 570 of Śaka elapsed + 9 months = 1349910, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

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method of the *Siddhāntas*, there can be no intercalary month in the solar month of *Agrahāyaṇa,* of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

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Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or α *Virginis*, in the latter part of the night.

On this day, at G. M. N., we had—

Mean Sun	$=264^\circ\ 57'\ 0''\cdot47$,	Hence—
,, Moon	$=180^\circ\ 14'\ 22''\cdot10$,	Apparent Sun $=265^\circ\ 8'$.
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From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa,* was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa*=29*da*. 30*n*. 24v. 2^{III} 33^{IV} (Burgess—*S. Siddhānta,* xiv, 3).

Length of Lunar month =29*da*. 31*n*. 50v. 6^{III} 53^{IV} (acc. to the *Khaṇḍakhādyaka*).

648 A.D., the year 330 of the Gupta era ended. *It must be admitted that the inscription as it has been read or as it was executed was slightly defective. In this case also Āryabhaṭa I's Caitra-Śuklādi reckoning is not followed.*

Here *330 of the Gupta era = 649 A.D.*

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गौप्ते ददावदोनृपः सोपरागेऽर्कमण्डले ॥
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This inscription says that on the day of the 5th *tithi* of the light half of lunar *Phālguna* of the Gupta year 585, the king of the place Morvi (22° 49′ N and 70° 53′ E) made a gift at the time of a solar eclipse, which happened some time before this date, on which the deed of gift, *viz.*, the copper plate in question, was executed.

To find the date of this copper plate, had been a pit-fall for Dr. Fleet, who mistook that the solar eclipse in question happened on the 7th May, 905 A.D. Now the year 585 of the Gupta should be 904 A.D. and the date of execution of the plate should be Feb. 20, 904 A.D. We looked for the solar eclipse, two lunations + 5 days before and 8 lunations + 5 days before this date. Although there happened the two solar eclipses at these times, they were not visible in India.

We find, however, that here the Gupta year is reckoned not from the light half of *Pauṣa*, but from the light half of *Caitra* according to Āryabhaṭa I's rule. Here the year 585 of the Gupta era = 826 of the *Caitra-Śuklādi* Saka era = 904-905 A.D., or the Zero year of the Gupta era = 319-20 A.D. the date of the inscription corresponds to March 3, 1941 A.D., and the elapsed years till this date = 1036 years = 12814 lunations = 378405 days. The date of the copper plate works out to have been *Feb. 12, 905 A.D.* The eclipse referred to in the inscription happened on

1 Finally accepted by Fleet—Indian Antiquary, Nov., 1891, page 382. S. B. Dīkṣita did actually find it.

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun	=234° 22′ 29″·34,
Sun's Apogee	= 83° 9′ 18″·32,
Mean Moon	=231° 7′ 21″·80,
D. Node	=246° 7′ 31″·10,
Lunar Perigee	=162° 10′ 10″·68.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era+8 lunations=87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become:—

Mean Sun	=228° 18′ 5″,
,, Moon	=224° 27′ 36″,
D. Node	=239° 44′ 56″,
Lunar Perigee	=155° 59′ 47″.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā-vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era	=475 A.D.
Julian days on Jan. 1, 475 A.D.	=1894552, and
,, ,, ,, ,, ,, 1900 A.D.	=2415021.

The difference is 520469 days which comprise 14·24 Julian centuries+253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11-4 a.m. Ujjayinī M.T.,

Mean Jupiter $=170° \ 54' \ 6''.57$,

Mean Sun $=269° \ 47' \ 11''.66$.

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later, *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

Mean Jupiter $= 194° \ 55' \ 34''·42$,

Mean Sun $= 194° \ 38' \ 19''·15$.

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively $-2° \ 6' \ 4''·01$ and $-1° \ 45' \ 2''·70$. Hence their apparent places became as follows:—

Appt. Jupiter $= 192° \ 49' \ 30''·41$,

,, Sun $= 192° \ 53' \ 16''·45$.

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

Appt. Sun $=208° \ 45'$, and

,, Jupiter $=196° \ 20'$ nearly.

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter.

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम् । [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941−482=1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

$$\text{Mean Jupiter} = 29^\circ\ 58'\ 8''{\cdot}24,$$
$$\text{,, Sun} = 347^\circ\ 12'\ 47''{\cdot}11.$$

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

$$\text{Mean Jupiter} = 32^\circ\ 27'\ 46''{\cdot}22,$$
$$\text{,, Sun} = 16^\circ\ 46'\ 57''{\cdot}02 \text{ at G.M.N.}$$

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇī*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D , which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

[1] Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or *a Virginis*, on the 20th Jan. before sunrise. Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्बत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A.D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date, Feb. 12, 510 A.D.

1 Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 133·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days=5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule:

युगवर्ष मास दिवसाः समंप्रवृत्तास्ते चैत्रशुक्लादेः ।

Kālakriyā, 11.

On June 16, 63 B.C., at G. M. N., we had—

		Hence—
Mean Sun	= 81° 38′ 59″·72,	Appt. Moon = 80° 45′
,, Moon	= 80° 20′ 8″·16,	,, Sun = 81° 11′
Lunar Perigee	= 76° 0′ 2″·58,	Jupiter as corrected by the equation of apsis, = 85° 54′ 54″.
Sun's Apogee	= 67° 39′,	*ν Cancri* = 97° 5′.
Mean Jupiter	= 80° 52′ 26″·87,	
Jupiter's Perihelion	= 341° 34′ 32″,	
,, Eccentricity	= ·0443845.	

Jupiter had set already and the new-moon happened in the *nakṣatra Punarvasu* ; the Jovial year begun was thus *Pauṣa* or *Mahāpauṣa*. The longitude of the oldest first point of the Hindu sphere was about, −6° in this year and consequently the longitude of the first point of the *Puṣyā* division was=87°20′. Jupiter was very near to this point. It may thus be inferred that the signal from Jupiter's position as to the beginning of the *Kṛtayuga* was taken to occur on this date, *viz.*, June 16, 63 B.C.

Again on July 16, 63 B.C., at G.M.T. 0 hr., or exactly one synodic month later—

		Hence—
Mean Sun	= 110° 43′ 37″·39,	Appt. Moon = 110° 57′,
,, Moon	= 109° 2′ 21″·48,	,, Sun = 109° 23′,
Lunar Perigee	= 79° 17′ 13″·71,	Jupiter as corrected by the eqn. of apsis = 88° 19′.
Mean Jupiter	= 83° 19′ 35″·21.	

On this day also the sun, moon, Jupiter and the *nakṣatra Puṣyā* were in the same cluster. This day also most probably afforded another signal for the coming of the *Kṛtayuga*. Jupiter had become heliacally visible about 10 days before.

If we go forward by 12 lunations from the above date, we arrive at July 5, 62 B.C., on which, at G.M.N.,

Mean Sun	= 100° 8′ 20″·52,
,, Moon	= 100° 4′ 19″·20,
,, Jupiter	= 112° 47′ 44″·98.
δ *Cancri*	= 100° 4′ nearly.

Here was another combination of the planets, which might have persuaded men that the *Kṛtayuga* had begun.

On the whole it is thus established that both the luni-solar, and the luni-solar-Jovial-stellar combined signals for the beginning of the *Kṛtayuga*, could be observed and estimated in the year 63 B.C. In this year the sun's reaching the winter solstice happened on Dec. 24, and the full-moon

day of *Pauṣa* was the day following it. The actual starting of the *Kṛta, Mālava* or the *Saṁvat* era was made 5 years later from the full-moon day of about the 28th Dec., 58 B.C. The *Saṁvat* year 1 was thus almost the same as 57 B.C., and that the number of the *Saṁvat* era represents the current year as in the Christian era. Further the lunar months here are full-moon ending as originally in the Śaka era, as we have seen in the preceding chapters. The year was reckoned from the full-moon day of *Pauṣa*. In 499 A.D. or some years later than this date, the *Caitra-Śuklādi* reckoning was followed according to the rule of Āryabhaṭa. But in the *Saṁvat* era, we are told that the lunar months are still reckoned as full-moon ending, which is now a case of a queer combination of opposites. We next turn to solve the last problem from the epigraphic source in relation to this era.

Mālava Saṁvat 529, the Second Day of the Light Half of Phālguna and the Beginning of Spring

In Fleet's Gupta Inscriptions, Plate No. 18, it is stated that spring had set in on the second day of the light half of *Phālguna* of the Mālava *Saṁvat* 529 or 473 A.D. Now the year in our time which was similar to 529 of the Malava era was 1932 A.D., and the date, to March 9, 1932. Elapsed years till this date was=1459 sidereal years=18046 lunations=5320909 days. These days are applied backward to March 9, 1932 A.D., and we arrive at the date :—

Feb. 15, 473 A.D., on which, at the Ujjayinī mean midnight,

Mean Sun	=326° 58′ [illegible]8″·09,	Hence—
,, Moon	=355° 57′ 22″·72,	Appt. Sun=328° 48′ 24″,
Lunar Perigee	=233° 43′ 28″·68,	,, Moon=360° 20′
Sun's Apogee	= 76° 46′ 14″·81,	nearly.
,, Eccentricity	=·017323.	

Now the Indian spring begins, when the sun's longitude becomes 330°, which happened about 30 hours later, *i.e.*, on the 17th Feb., 473 A.D. The local conditions probably brought in spring earlier.

Again 2·5 days before Feb. 15, 473 A.D., at Ujjayinī mean midnight, or on the 13th February, 473 A.D.. at Ujjayinī mean midday :—

Mean Sun	$=324° 30' 47''·25$,
Mean Moon	$=323° 0' 55''·12$,
Lunar Perigee	$=233° 26' 46''·04$.

It appears that the new-moon had happened about 3½ hrs. before, and the first visibility of the crescent took place on the evening of the next day, the 14th Feb. Thus Feb. 15 was the second day of the month, as stated in the inscription.

We now proceed to consider why there has been an error in estimating the beginning of spring, which according to an old rule should come 60 days after the winter solstice day. We find that 60 days before this date, *viz.*, Feb. 15, or, on :—

Dec. 17, 472 A.D., at Ujjayini mean midday,

Mean Sun	$=267° 20' 37''$,
,, Moon	$=284° 48' 4''$,
Lunar Perigee	$=226° 59' 5''$.

The estimated winter solstice day was thus premature by about two days. On this day, the first visibility of the crescent took place in the evening. Hence the second day of the light half of *Phālguna* was the estimated beginning of spring, *i.e.*, 60 days later. The new-moon happened on the 16th December and the real winter solstice day was the 19th December.

This inscription shows that the Gupta era cannot be identified with the *Saṁvat* era. The point that why or how the Mālava era came to be called Vikrama *Saṁvat* cannot be answered from any astronomical data,

Note.—We have here tried to interpret the astronomical statement of the Mandasor stone inscription of Kumara Gupta and Bandhuvarman. The date of the inscription found here as Feb. 15, 473 A.D., was that of the thorough repair and decoration of the sun temple at Mandasor (24°3′N and 75°8′E). The inscription says that spring has set in.

CHAPTER XXV

INDIAN ERAS

The Gupta Era

In the present chapter, it is proposed to determine the beginning of the era of the Gupta emperors of northern India. Dr. Fleet in his great book *Inscriptionum Indicaram*, Vol. III, has published a collection of the Gupta inscriptions. In order to verify the dates in those inscriptions he had the assistance of the late Mr. S. B. Dīkṣita of Poona, and his calculations led Dr. Fleet to conclude that the Gupta era began from 319-21 A.D.[1] This indefinite statement or inference is not satisfactory. Mr. Dīkṣita was also not able to prove that the Gupta and Valabhī eras were but one and the same era.[2] Of recent years some have even ventured to prove that the Gupta era is to be identified with the *Saṁvat* or Mālava era. Hence it has become necessary to try to arrive at a definite conclusion on this point, *viz.*, the true beginning of the Gupta era.

The tradition about this era is recorded by Alberunī, which is equivalent to this:—From the Śaka year, deduct 241, the result is the year of the Gupta kings and that the Gupta and Valabhī eras are one and the same era.[3] Now the Śaka era and the *Saṁvat* or Mālava era are generally taken to begin from the light half of lunar *Caitra*. As has been stated already, it is extremely controversial to assume if this was so at the times when these eras were started.

From the earliest Vedic times and also from the *Vedāṅga* period, we have the most unmistakable evidences to show that the calendar year, as distinguished from the sacrificial year, was

1 Fleet—*Corpus Inscriptionum Indicarum*, Vol. III (Gupta Inscriptions), page 127.

2 S. B. Dīkṣita, भारतीय ज्योतिःशास्त्र, page 375 (1st Edn.).

3 Sachau's Alberuni, Vol. II, page 7—" The epoch of the era of the Guptas falls, like that of the Valabha era, 241 years later than the *Śakakāla*."

started either from the winter solstice day or from the day following it. The so-called *Caitra-Śuklādi* reckoning started the year from the vernal equinox day or from the day following it. So far as we can see from a study of the history of Indian astronomy, we are led to conclude that this sort of beginning the year was started by Āryabhaṭa I from 499 A.D. The great fame of Āryabhaṭa I, as an astronomer, led all the astronomers and public men of later times to follow him in this respect. We start with the hypothesis that the Gupta era was originally started from the winter solstice day and that initially the year of the era more correctly corresponded with the Christian year, than with the *Caitra Suklādi* Śaka year.

Now the year 241 of the Śaka era is equivalent to 319-20 A.D. We assume that the Gupta era started from the winter solstice day preceding Jan. 1, 319 A.D. The elapsed years of the Gupta era till 1940 A.D., becomes 1621 years and $1621 = 160 \times 10 + 19 + 2$. Hence the starting year of the era was similar to 1938 A.D. Now the mean precession rate from 319 to 1938 A.D. $= 50''\cdot0847$ per year. Hence the total shifting of the solstices becomes till 1938 A.D. $= 22° 31' 27''\cdot54$. Thus what was 270° of the longitude of the sun, should now become 291° 31′ nearly—a longitude which the sun now has about the 13th of January. On looking up some of the recent calendars we find that:—

(*a*) In the year 1922, there was a full-moon on Jan. 13.
(*b*) ,, ,, ,, 1937, ,, ,, a new-moon on Jan. 12.

We apply the elapsed years 1619 (sidereal) backward to Jan. 12, 1937 A.D., and arrive at the date:—

Dec. 20, 317 A.D., on which, at G.M.N., or Ujjayinī M.T. 5-4 p.m.,

Mean Sun	$= 269° \; 5' \; 11''\cdot26$,	Hence $2e = 119'\cdot5016$,
,, Moon	$= 272° \; 39' \; 40''\cdot40$,	$\frac{5}{4}e^2 = 1'\cdot2981$,
Lunar Perigee	$= 39° \; 50' \; 37''\cdot25$,	Appt. Sun $= 269°37'$.
A. Node	$= 257° \; 44' \; 29''\cdot88$,	,, Moon $= 268°52'$ nearly.
Sun's Apogee	$= 74° \; 7' \; 25''\cdot16$,	
,, Eccentricity	$= \cdot0173808$.	

The moon overtook the sun in about 1¼ hours and the sun reached the winter solstice in about 9 hours. Hence Dec. 20, 317 A.D., was a new-moon day and also the day of winter solstice

according to the ordinary mode of Indian reckoning. As this day was similar to Jan. 12, 1937 A.D., *viz.*, lunar *Agrahāyaṇa* ended, it appears that the Gupta era was started from about the 21st Dec., 318 A.D., and this was the 12th day of lunar *Pauṣa.* It must be remembered in this connection, that the distinguishing character of the lunar *Agrahāyaṇa*, with which the year ended at the end of a correct luni-solar cycle, was that the last quarter of the moon was very nearly conjoined with *Citrā* (*Spica* or *α Virginis*).[1] In our opinion this character of the month was used for the intercalation of a lunar month at the end of a correct luni-solar cycle. We now proceed to examine the dates given in the Gupta Inscriptions as collected together by Dr. Fleet in his great book on the subject.

I. The First Instance of Gupta Inscription Date

शते पञ्चषष्ट्यधिके (१६५) वर्षाणाम् भूपतौ च बुधगुप्ते आषाढ़ मास शुक्लद्वादश्यां सुरगुरोर्दिवसे ।[2]

The inscription says that the 12th *tithi* of the light half of lunar *Āṣāḍha* of the Gupta year 165 fell on a Thursday. We examine this by both the modern and the *Siddhāntic* methods.

(A) By the Modern Method.

The year 165 of the Gupta kings is similar to the year 1924 A.D. The elapsed years till this date = 1440 sidereal years = 525969 days. We increase the number of days by 1 and divide it by 7 ; the remainder is 4, which shows that the inscription statement of Thursday agrees with the Sunday of July 13, 1924 A.D.

We next apply 525969 days backward to July 13, 1924, and arrive at the date June 21, 484 A.D., the date of the inscription.

This date was 14·15 Julian centuries + 181·25 days before Jan. 1, 1900 A.D. Hence—

On June 21, 484 A.D., at G.M.N.,

Mean Sun	$= 91° \ 12' \ 50''\cdot64$,	Hence—
,, Moon	$= 235° \ 7' \ 53''\cdot42$,	$2e = 119'\cdot0564$.
Lunar Perigee	$= 335° \ 23' \ 2''\cdot80$,	$\frac{5}{4}e^2 = 1'\cdot290$.
A. Node	$= 277° \ 14' \ 51''\cdot51$,	
Sun's Apogee	$= 76° \ 14' \ 32''$,	
,, Eccentricity	$= \cdot0173175$.	

1 *Cf.* the longitude of the moon on Jan. 4, 1937 A.D., at L. Q. with that of *α Virginis*.

2 Fleet's—Gupta Inscriptions, page 80, Eran Inscription.

From these we readily find the same mean places at the preceding Ujjayinī mean midnight. Hence—

On June 20, 484 A.D., at Ujjayinī mean midnight,

Mean Sun	= 90° 30′ 47″·38,	
,, Moon	=225° 45′ 41″·78,	Appt. Sun = 90° 2′,
Lunar Perigee	=335° 18′ 17·61,	,, Moon=219° 47′ nearly.
A. Node	=277° 17′ 7″·08.	

Thus at the Ujjayinī mean midnight of the day before (Wednesday), the 11th *tithi* was current, and next day, *Thursday*, had at sun rise the 12th *tithi* of the lunar month of *Āṣāḍha*.

(B) According to the method of the *Khaṇḍakhādyaka* of Brahmagupta, the *Kali ahargaṇa* on this Wednesday at the Ujjayinī mean midnight was=1309545. Hence—

Mean Sun	= 91° 3′ 4″,
,, Moon	=226° 23′ 17″,
Lunar Perigee	=335° 42′ 56″,
A. Node	=277° 35′ 17″.

The above two sets of the mean elements for the same instant are in fair agreement. *Hence the date of the inscription is Thursday, June 21, 484 A.D., and the Zero year of the Gupta era is thus 319 A.D. We are here in agreement with Dīkṣita's finding.*

II. The Second Instance of Gupta Inscription Date

श्रीविश्वनाथ प्रतिवद्ध नोजनानां वोधक रसुल महम्मद संवत् ६६२ तथा श्रीनृप विक्रम संवत् १३२० तथा श्रीमद् वलभी संवत् ९४५ आषाढ़ वदि १३ रवौ अद्य इह ।[1]

Here the *Hijrī* year 662 shows the Vikrama *Saṁvat* is expressed in elapsed years as 1320 ; and as it is now reckoned it should be 1321. The Valabhi *Saṁvat* 945 is the same as the Gupta *Saṁvat* 945, in which the 13th *tithi* of the dark half of *Jyaiṣṭha* fell on a Sunday.

Now the mean *Khaṇḍakhādyaka ahargaṇa*

=218878

from which we deduct 30

211848,

which we accept as the correct *ahargaṇa* and is exactly divisible

1 Fleet—Gupta Inscriptions, page 84, Veraval Inscription.

by 7, and which was true for Saturday of *Āṣāḍha vadi* 12 of the Gupta era 945. The English date for this Saturday was May 25, 1264 A.D. On the next day, Sunday, the date was, May 26, 1264 A.D., the date of the inscription.

From the above apparent *ahargaṇa* for May, 25, 1264 A.D., which was a Saturday, at the Ujjayinī mean midnight, we have

Mean Sun = $1^s\ 27^\circ\ 42'\ 48''$,
,, Moon = $0^s\ 27^\circ\ 31'\ 40''$,
Lunar Apogee = $6^s\ 20^\circ\ 29'\ 1''$ (with Lalla's correction)
A. Node = $9^s\ 29^\circ\ 53'\ 4''$ (Do. Do. Do)
Hence, Appt. Sun = $1^s\ 28^\circ\ 21'\ 57''$,
,, Moon = $0^s\ 28^\circ\ 8'\ 44''$,
∴ Moon − Sun = $10^s 29^\circ\ 46'\ 47''$
= 27 *tithis* + $5^\circ\ 46'\ 47''$.

Thus at the midnight (U.M.T.) of the Saturday ended, about 11 hrs. of the 13th *tithi* of the dark half of *Jyaiṣṭha* were over and 13 hrs. nearly of it remained. Thus the current *tithi* of the next morning of Sunday was also the 13th of the dark half of *Jyaiṣṭha* which is called *Āṣāḍha vadi* 13.

In the present case the Valabhi or Gupta year 945=1264 A.D. Hence also the Gupta era began from 319 A.D., and we are in agreement with Dīkṣita.

III. *The Third Instance of Gupta Inscription Date*

९२७ वर्षे फाल्गुन सुदि २ सोम । [1]

It is here stated that in the Gupta or Valabhī year 927, the 2nd *tithi* of the light half of *Phālguna* fell on a Monday. The English date becomes 1246 A.D., Feb. 19. Śaka year was 1167 years + 11 months + 2 *tithis*, the Gupta year being taken to have been reckoned from the light half of lunar *Pauṣa*.

[1] Fleet's Gupta Inscriptions, page 90, Veraval Inscription.

The true *Khaṇḍakhādyka ahargaṇa* becomes = 212179 at Ujjayinī mean midnight of monday, when

$$\begin{aligned} \text{Mean Sun} &= 10^s\ 24^\circ\ 43'\ 44'', \\ \text{,, Moon} &= 11^s\ 24^\circ\ 26'\ 37'', \\ \text{Lunar Apogee} &= 6^s\ 3^\circ\ 20'\ 53'', \\ \text{A. Node} &= 2^s\ 1^\circ\ 59'\ 40''. \end{aligned}$$

Hence on the same date at 6 a.m., Ujjayinī M.T.,

Mean Sun = $10^s\ 23^\circ\ 59'\ 23''$,	Thus—
Sun's Apogee = $2^s\ 17^\circ\ 0'\ 0''$,	Appt. Sun = $325^\circ\ 59'\ 2''$,
Mean Moon = $11^s\ 14^\circ\ 33'\ 41''$,	,, Moon = $342\ \ 56'\ 51''$.
Lunar Apogee = $6^s\ 3^\circ\ 15'\ 52''$	

$$\begin{aligned} \therefore \text{Moon} - \text{Sun} &= 16^\circ\ 57'\ 25'' \\ &= 1\ \textit{tithi} + 4^\circ\ 57'\ 25''. \end{aligned}$$

On this Monday, the *tithi* was the second of the light half of unar *Phālguna,* while the sun's longitude shows that the Bengali date was the 24th of solar *Phālguna*. We are here in agreement with Dīkṣita.

In this case also calculation by the modern methods is unnecessary as the time was later than of Brahmagupta. It should be noted that the old year-reckoning from the light half of *Pauṣa* persists inspite of Āryabhaṭa I's rule of reckoning it from the light half of *Caitra*. Here also 927 of the Gupta Era =1246 A.D.

∴ Zero year of the Gupta Era = 319 A.D.

IV. The Fourth Instance of Gupta Inscription Date

३३० गुप्त संवत द्विमार्गशीर शुदि २ ।[1]

This states that the Gupta year 330 had at its end the second *Agrahāyaṇa*. Here, the Gupta year 330, up to *Agrahāyaṇa*, the time by the *Caitra-Śuklādi* Śaka era would be 570 years + 9 months.

According to the *Khaṇḍakhādyaka* of Brahmagupta the total *Kali-solar* days up to 570 of Śaka elapsed + 9 months = 1349010, in which we get $1383\frac{12}{976}$ intercalary months, *i.e.*, 1383 exact intercalary months by the mean rate, which tends to show that there was a second lunar *Agrahāyaṇa* at this time. But this explanation appears unsatisfactory. If we follow the

[1] Fleet—Gupta Inscriptions, page 92, the Kaira (22°45′N, 72°45′E) Grant.

method of the *Siddhāntas*, there can be no intercalary month in the solar month of *Agrahāyaṇa*, of which the length as found by Warren is less than that of a lunar month.[2] We have also examined it carefully and found that in the present case this could not happen. We have then to examine it another way.

On Dec. 20 of the year 317 A.D., there was a new-moon with which the lunar *Agrahāyaṇa* ended and the sun turned north. The character of this lunar *Agrahāyaṇa* was that the last quarter was conjoined with *Citrā* or *α Virginis*. The Gupta era was started one year later than this date, from the 20th Dec., 318 A.D. The year 330 of the Gupta era was thus the year which ended about Dec. 20, 648 A.D. and the number of years elapsed was $=331=160\times2+11$.

Thus 331 years was a fairly complete luni-solar cycle, and comprised 120898 days. Again 577825 days before Jan. 1, 1900 A.D., was the date Dec. 20, 317 A.D. Hence applying 120898 days forward to this date, we arrive at the date Dec. 20, 648 A.D., on which the new-moon happened with which the lunar *Agrahāyaṇa* ended this year.

Now on the day of the last quarter of this month or the *aṣṭakā* which fell on the 13th Dec., 648 A.D., the moon was conjoined with *Citrā* or *α Virginis*, in the latter part of the night.

On this day, at G. M. N., we had—

Mean Sun	$=264^\circ\ 57'\ 0''\cdot47$,	Hence—	
,, Moon	$=180^\circ\ 14'\ 22''\cdot10$,	Apparent Sun	$=265^\circ\ 8'$.
Lunar Perigee	$=188^\circ\ 32'\ 34''\cdot17$,	,, Moon	$=179^\circ\ 10'$,
Sun's Apogee	$=\ 79^\circ\ 46'\ 40''\cdot79$.	Long. of *α Virginis*	$=185^\circ$ nearly
$2e=118'\cdot7$, $\frac{5}{4}e^2=1'\cdot398$.			

From these calculations it follows that the last lunar month of the year, was the second *Agrahāyaṇa* as this month completed the luni-solar cycle of 331 years.

The date of the inscription, being the second day of the second *Āgrahāyaṇa*, was *the 22nd of November, 648 A.D.* With this second *Agrahāyaṇa* which ended on the 20th Dec.,

[2] Length of Solar *Agrahāyaṇa*$=29$*da.* 30*n.* 24*v.* $2^{\text{III}}\ 33^{\text{IV}}$ (Burgess—*S. Siddhānta*, xiv, 3).

Length of Lunar month $=29$*da.* 31*n.* 50*v.* $6^{\text{III}}\ 53^{\text{IV}}$ (acc. to the *Khaṇḍakhādyaka*).

648 A.D., the year 330 of the Gupta era ended. *It must be admitted that the inscription as it has been read or as it was executed was slightly defective. In this case also Āryabhaṭa I's Caitra-Śuklādi reckoning is not followed.*

Here *330 of the Gupta era = 649 A.D.*

∴ *Zero of the ,, ,, = 319 A.D.*

V. Morvi Copper Plate Inscription

पञ्चाशीत्यायुतेऽतीते समानां शतपञ्चके ।
गौप्ते ददावदोनृपः सोपरागेऽर्कमण्डले ॥
संवत् ५८५ फाल्गुन सुदि ५ ।

This inscription says that on the day of the 5th *tithi* of the light half of lunar *Phālguna* of the Gupta year 585, the king of the place Morvi (22° 49′ N and 70° 53′ E) made a gift at the time of a solar eclipse, which happened some time before this date, on which the deed of gift, *viz.*, the copper plate in question, was executed.

To find the date of this copper plate, had been a pit-fall for Dr. Fleet, who mistook that the solar eclipse in question happened on the 7th May, 905 A.D. Now the year 585 of the Gupta should be 904 A.D. and the date of execution of the plate should be Feb. 20, 904 A.D. We looked for the solar eclipse, two lunations + 5 days before and 8 lunations + 5 days before this date. Although there happened the two solar eclipses at these times, they were not visible in India.

We find, however, that here the Gupta year is reckoned not from the light half of *Pauṣa*, but from the light half of *Caitra* according to Āryabhaṭa I's rule. Here the year 585 of the Gupta era = 826 of the *Caitra-Śuklādi* Śaka era = 904-905 A.D., or the Zero year of the Gupta era = 319-20 A.D. the date of the inscription corresponds to March 3, 1941 A.D., and the elapsed years till this date = 1036 years = 12814 lunations = 378405 days. The date of the copper plate works out to have been *Feb. 12, 905 A.D.* The eclipse referred to in the inscription happened on

[1] Finally accepted by Fleet—Indian Antiquary, Nov., 1891, page 382. S. B. Dīkṣita did actually find it.

Nov. 10, 904 A.D.,[1] on which, at G.M.N. or 4-44 p.m. Morvi time,

Mean Sun =234° 22′ 29″·34,
Sun's Apogee = 83° 9′ 18″·32,
Mean Moon =231° 7′ 21″·80,
D. Node =246° 7′ 31″·10,
Lunar Perigee=162° 10′ 10″·68.

The new-moon happened at mean noon Morvi time, the magnitude of the eclipse as visible at the place was about ·075. The beginning of the eclipse took place at 11-35 a.m. Morvi time, the end came about 12-45 noon Morvi mean time. Duration was about 1 hr. 10 min.[1]

Secondly, if we use the *Khaṇḍakhādyaka* constants, the *ahargaṇa* becomes for 826 of Śaka era+8 lunations=87528. Hence the mean places with Lalla's corrections thereto, at G.M.N. at the same day, become:—

Mean Sun =228° 18′ 5″,
,, Moon =224° 27′ 36″,
D. Node =239° 44′ 56″,
Lunar Perigee =155° 59′ 47″.

It appears that this eclipse could be predicted by the method of the *Khaṇḍakhādyaka*. The gift made by this copper plate was probably a reward to the calculator of the eclipse.

VI. The Sixth Instance of Gupta Inscription Date

षट्पञ्चाशोत्तरेऽब्दशते (१५६) गुप्तनृपराज्यभुक्तौ महावैशाखसंवत्सरे कार्त्तिक मास शुक्लपक्षतृतीयायां । [2]

In the year 156 of the Guptas, which was the Jovial year styled the *Mahā vaiśākha* year, the inscription records the date as the day of the 3rd *tithi* of the light half of *Kārtika*.

Now 156 of the Gupta era =475 A.D.
Julian days on Jan. 1, 475 A.D. =1894552, and
,, ,, ,, ,, ,, 1900 A.D. =2415021.

The difference is 520469 days which comprise 14·24 Julian centuries+253 days. We increase 520469 days by 12·25 days and

[1] The above circumstances of the eclipse have been calculated by my collaborator, Mr. N. C. Lahiri, M.A.

[2] Fleet—Gupta Inscriptions, page 104, the Khôh Grant.

arrive at the date, Dec. 20, 474 A.D., on which, at G.M.T. 6 hrs. or 11-4 a.m. Ujjayinī M T.,

Mean Jupiter $=170^\circ\ 54'\ 6''.57$,

Mean Sun $=269^\circ\ 47'\ 11''.66$.

Hence we calculate that mean Jupiter and mean Sun became nearly equal 289 days later, *i.e.*, on the 17th September, 475 A.D., at 6 a.m. G.M.T.,

Mean Jupiter $= 194^\circ\ 55'\ 34''\cdot 42$,

Mean Sun $= 194^\circ\ 38'\ 19''\cdot 15$.

It is thus seen that the mean places would become almost equal in 6 hrs. more. For the above mean places, however, the equations of apsis for Jupiter and Sun were respectively $-2^\circ\ 6'\ 4''\cdot 01$ and $-1^\circ\ 45'\ 2''\cdot 70$. Hence their apparent places became as follows:—

Appt. Jupiter $= 192^\circ\ 49'\ 30''\cdot 41$,

,, Sun $= 192^\circ\ 53'\ 16''\cdot 45$.

Thus they were very nearly in conjunction at 6 hrs. G.M.T. on the 17th September, 475 A.D.

According to Brahmagupta, Jupiter rises on the east on getting at the anomaly of conjunction of 14°. This takes place in 15·5 days. Hence the date for the heliacal rising of Jupiter becomes the 2nd October, 475 A.D., at G.M.T. 18 hrs., when—

Appt. Sun $=208^\circ\ 45'$, and

,, Jupiter $=196^\circ\ 20'$ nearly.

Thus Jupiter was heliacally visible about Oct. 20, 475 A.D. The actual date of the inscription was **Oct. 18, 475 A.D.**

Here on the day of the heliacal visibility, the sun was in the *nakṣatra Viśākhā*, but Jupiter was 3° 40′ behind the first point of the *nakṣatra* division, the Vernal Equinox of the year being taken as the first point of the Hindu sphere. According to the rule of naming Jupiter's years as given in the modern *Sūrya Siddhānta*, XIV, 16-17, it was sun's *nakṣatra*, on the new-moon prior to October 18, 475 A.D., the date of the

inscription, which took place on Oct. 15-16 of the year, gave the name of the year. The sun would reach the *nakṣatra Anurādha*, and the year begun was consequently *Mahā vaiśākha* year of Jupiter.

This inscription also shows that the Gupta era began from 319 A.D.

VII. The Seventh Instance of Gupta Inscription Date

त्रिषष्ट्युत्तरेऽब्दशते (१६३) गुप्तनृपराज्यभुक्तौ महाआश्वयुज-संवत्सरे चैत्रमास-शुक्ल-पक्ष द्वितीयायाम् । [1]

The inscription records the date as the year 163 of the Gupta kings, the Jovial year called *Mahā Āśvayuja*, the day of the 2nd *tithi* of the light half of *Caitra*.

The year 163 of the Gupta era or 482 A.D. was similar to the year 1941 A.D., and the date to March 30, 1941 A.D. In 1459 sidereal years (1941 − 482 = 1459), there are 532909 days, which are applied backward to the 30th March, 1941 A.D., and we arrive at the tentative date of the inscription as March 8, 482 A.D. On this date, at G.M.N., we had—

$$\text{Mean Jupiter} = 29^\circ\ 58'\ 8''{\cdot}24,$$
$$\text{,, Sun} = 347^\circ\ 12'\ 47''{\cdot}11.$$

Here, Jupiter's heliacal setting is yet to come in about 30 days. Hence on April 7, 482 A.D.,

$$\text{Mean Jupiter} = 32^\circ\ 27'\ 46''{\cdot}22,$$
$$\text{,, Sun} = 16^\circ\ 46'\ 57''{\cdot}02 \text{ at G.M.N.}$$

Thus the heliacal setting of Jupiter took place in two days more according to Brahmagupta's rule on the 9th April, 482 A.D., and the new-moon happened on the 5th April, 482 A.D., when the sun was in the *nakṣatra Bharaṇī*. Hence the year to come got its name *Āśvayuga* year. But the tentative date of the inscription was obtained as March 8, 482 A.D , which was 21 days before the new-moon on about the 5th April, 482 A.D. This needs elucidation.

[1] Fleet—Gupta Inscriptions, page 110, the Khôh Grant II

Here by coming down by 30 days we arrive at the lunar month of *Vaiśākha* as it is reckoned now. But in the year 482 A.D., *i.e.*, 17 years before the year 499 A.D., when the Hindu scientific *siddhāntas* came into being, the calendar formation rule was different. In our gauge year 1941 A.D. the moon of last quarter got conjoined with *Citrā* or *α Virginis*, on the 20th Jan. before sunrise Hence as pointed out before in this gauge year 1941 A.D. also, the lunar *Agrahāyaṇa* of the early Gupta period ended on the 27th Jan., 1941 A.D. Thus the lunar month that is now called *Pauṣa* in 1941 A.D. was called *Agrahāyaṇa* in 482 A.D. Hence the lunar *Caitra* of 482 A.D. is now the lunar *Vaiśākha* of 1941 A.D.

The date of this inscription is thus correctly obtained as the *7th April, 482 A.D.*; the Jovial year begun was a *Mahā Āśvayuja* year. This instance also shows that the Zero year of the Gupta era was approximately the same as the Christian year 319 A.D.

VIII. The Eighth Instance of Gupta Inscription Date

एकनवत्युत्तरेऽब्दशते (१९१) गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान महाचैत्रसम्वत्सरे माघ मास-बहुल-पक्षतृतीयायां ।[1]

This inscription records the date, as the year 191 of the Gupta emperors, the Jovial year of *Mahā-caitra*, the day of the third *tithi* of the dark half of lunar *Māgha*.

We first work out the date on the hypothesis that the Gupta year was in this case also reckoned from the light half of lunar *Pauṣa*. The Gupta year 191, on this hypothesis, would be similar to the Christian year 1931, and the date of the inscription would correspond with March 6, 1931 A.D. Now this Gupta year 191=510 A.D., would be later than the time of Āryabhaṭa I, *viz.*, 499 A.D., by 11 years.

The elapsed years (sidereal) are 1421, which comprise 17576 lunations=519029 days. These days are applied backward to the date, March 6, 1931 A.D., and we arrive at the date. Feb. 12, 510 A.D.

[1] Fleet—Gupta Inscriptions, page 114, the Majhgavām Grant.

On this date, Feb. 12, 510 A.D., at G.M.N., we had—

Mean Jupiter = 158° 8′ 3″·87.
,, Sun = 323° 46′ 13″·72.

We find easily the sun and Jupiter had reached equality in mean longitude in 133·5 days before, when, at G.M.T. 0 hr.,

Mean Sun = 142° 54′ 15″·50
Mean Jupiter = 142° 52′ 48·57.

If these were the longitudes as corrected by the equations of apsis, then the heliacal visibility would come according to the rule of Brahmagupta about 15·5 days later. The mean longitudes 15.5 days later become—

For Sun = 158° 10′ 54″·21.
For Jupiter = 144° 10′ 7″·25.

These, corrected by the equations of apsis, become—

For Sun = 156° 3′ 27″,
For Jupiter = 146° 16′ 41.

Hence the true heliacal visibility would come in 4 days more. We have here (1) gone up by 183·5 days and (2) come down by 15·5 days. On the whole we have gone up by 168 days or 5 lunations +21 *tithis*. Thus on the day of the heliacal visibility of Jupiter, which came in four days more, we would have to go up by 164 days = 5 lunations +17 *tithis*. This interval we have to apply backward to the 11th *tithi* of *Māgha*, and we arrive at the first day of *Bhādrapada*. The date of the heliacal visibility would thus be Sep. 1, 509 A.D., and at G.M.N. the sun's true longitude would be 160° 9′ nearly, which shows that the sun would reach the *Hastā* division. On the preceding day of the new-moon, the sun would be in the *nakṣatra U. Phalgunī*, and the Jovial year begun would be styled *Phālguna* or the *Mahā-phālguna year*. This result does not agree with the statement of the inscription.

It now appears that after the year 499 A.D. or Āryabhaṭa I's time, the reckoning of the years of the Gupta era was changed from the light half of *Pauṣa* to the light half of *Caitra*, according to Āryabhaṭa I's rule:

युगवर्ष मास दिवसाः समंप्रवृत्तास्ते चैत्रशुक्लादेः ।

Kālakriyā, 11.

" The yuga, year, month and the first day of the year started simultaneously from the beginning of the light half of *Caitra*."

After the year 499 A.D. all the Indian eras slowly changed their year reckoning from the winter solstice day to the next vernal equinox day, *i.e.*, the year beginning was shifted forward by 3 lunations. Hence in finding in our own time a year similar to the Gupta year, of times later than 499 A.D., we have sometimes to compare it to the present-day Śaka year and not to the Christian year.

Hence the year 191 of the Gupta era = the year 432 of the Śaka era. In our times the Śaka year 1853 is similar to the Gupta year 191 and the date of the inscription corresponds to Feb. 24, 1932 A.D. The number of sidereal years elapsed up to this date = 1421 = 519029 days, which applied backward lead to the date of the inscription as *Feb. 2, 511 A.D.*

The date of the heliacal rising arrived at before was Sept. 1, 509 A.D. The next heliacal rising would take place 399 days or 13·6 lunations later. The date for it works out to have been Oct. 5, 510 A.D., and the sun had the longitude of 194° 24′ 51″ at G.M.N. At the preceding new-moon, which followed the previous heliacal setting of Jupiter, the sun had the longitude of about 179°, and was in the *nakṣatra Citrā* or the Jovial year begun was *Caitra* or the *Mahā-caitra* year, as it is styled in the inscription.

In the present case the year 191 of the Gupta emperors = 432 of the Śaka emperors = 510-11 A.D. Thus the year Zero of the Gupta emperors = 241 of the Śaka emperors = 319-20 A.D.

IX. नवोत्तरेऽब्दशतद्वये गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्धमान-विजयराज्य महाआश्वयुज—सम्वत्सरे चैत्रशुक्लपक्षत्रयोदश्याम् ।

The year and date as given in this inscription is 209 of the Gupta era, the day of the 13th *tithi* of the light half of *Caitra*. Following the *Caitra-Śuklādi* reckoning, the corresponding date in our time is the 11th April, 1930 A.D. We have to apply 1402 sidereal years or more correctly 17341 lunations = 512090 days backward to this date of April 11, 1930 A.D. We thus arrive at the date of the inscription, *March 19, 528 A.D.*

On this day, at G.M.N., we had—

Mean Jupiter	=347° 37′ 23″·09,	Hence—
Mean Sun	=358° 53′ 52″·27,	Jupiter as corrected by the equation of apsis
Jupiter's Perihelion	=350° 51′ 21″·61,	=347° 19′,
Sun's Apogee	= 77° 42′ 56″,	Appt. Sun=358° 5′.
,, Eccentricity	=·017301,	
Jupiter's Eccentricity	=·046175.	

It appears that the heliacal rising of Jupiter would happen 3 days later and the preceding new-moon happened 13 days before, *i.e.*, on the 6th March, 528 A.D.

For on that date, at G.M.N., we had—

Mean Sun	=346° 5′ 3″·98,	Hence—
,, Moon	=343° 5′ 27″·90,	Appt. Sun =349° 4′,
Lunar Perigee	=313° 57′ 36″·84.	,, Moon=345° 43′, nearly.
Sun's Apogee	= 77° 42′ 56″.	

The new-moon happened at about 8 hours later. The sun was in the *nakṣatra Revatī*, and the Jovial year begun was *Āśvayuga* or the *Mahā Āśvayuja* year as the inscription says.

Here the year 209 of the Gupta era=528 A.D. =year 450 of Śaka era
∴ the Zero year of the Gupta era =319 A.D. =year 241 of Śaka era.

X. *The Tenth Instance of Gupta Inscription Date*

The Nepal Inscription

संवत् ३८६ जैग्ठ मास शुक्लपक्ष प्रतिपदि रोहिणी नक्षत्रयुक्ते मुहूर्त्ते प्रशस्तेऽ-भिजिति ।[1]

Here the date is stated to have been, 386 of the (Gupta) era, the day of the first *tithi* of lunar *Jyaiṣṭha*, the moon wasin the *nakṣatra* division *Rohiṇī* and the 8th part (*muhūrta*) of the day.

The equivalent years are 627 of Śaka era = 705 A.D.; we readily see that the corresponding day in our own time was, May 20, 1939. We arrive at the date, April 30, 705 A.D.

(1)		(2)	
Now on April 30, 705 A.D., at G.M.T. 0 hr.,		On April 29, 705 A.D., at G.M.T. 0 hr.,	
Mean Sun	= 40° 54′ 10″·97,	Mean Sun	= 39° 55′ 2″·64,
,, Moon	= 62° 0′ 9″·07,	Mean Moon	= 48° 49′ 34″·04,
Lunar Perigee	= 322° 39′ 15″·02	L. Perigee	= 322° 32′ 33″·97

[1] Fleet—Gupta Inscriptions, page 95. This inscription does not present any peculiar feature.

Thus on April 29, 705 A.D., at G.M.T. 0 hr.,

Apparent Sun = 41° 12′
,, Moon = 53° 50′.

Hence on this day, at the stated hour, the first *tithi* was over ; we have to deduct about 3° 3′ from these longitudes (mean) to allow for the shifting of the equinoxes from 499 A.D. The date of the inscription is thus *April 28, 705 A.D.*

According to the *Khaṇḍakhādyaka* calculations the *ahargaṇa* at the midnight (mean) of Ujjayinī of April 28 = 14647. In order to have the mean places at the G.M.T. 0 hr., of 29th April, we have to take the *ahargaṇa* = 14647 days + 5 hrs. and 4 min. The mean places are—

Mean Sun = 36° 52′ 12″,	Hence—
Mean Moon = 45° 43′ 58″,	Apparent Sun = 38° 16′ 23″,
Sun's Apogee = 77° 0′ 0″,	,, Moon = 50° 44′ 30″.
Lunar Perigee = 318° 56′ 2″.	

Note :—To the *Khaṇḍakhādyaka* mean places, we have applied Lalla's corrections which are well-known in Hindu Astronomy,

Hence on the 29th April at G.M.T. 0 hr. = 5-4 a.m. of Ujjayinī mean time, the first *tithi* was over, the sun was in the *nakṣatra Kṛttikā* and the moon in the *nakṣatra* division *Rohiṇī*, which extends from 40° to 53° 20′ of the Hindu longitudes. The date of the inscription was the previous day, the **28th April, 705 A.D.**, as has been shown before.

Now Gupta year, 386 = Śaka year 627 = 705 A.D.

∴ Gupta year, Zero = Śaka year 241 = 319 A.D.

XI. *The Eleventh Example of Gupta Inscription Date*

संवत्सर १०० ९० ९ (१९९) महामार्गवर्षे कार्त्तिक १० ।[1]

The date of the inscription is the Gupta year 199, the *Mahā-mārga* Jovial year, the day of the 10th *tithi* of lunar *Kārtika*, which corresponds to Nov. 21 of 1939 A.D. of our times. The elapsed siderial years to this date = 1421 = 1757.6 lunations = 519029 days.

1 *Epigraphica Indica*, Vol, VIII, pp. 284 *et seq.*

Hence the date of the Inscription was **Oct. 29, 518 A.D**

On this date, at G.M.N.,

Mean Jupiter = 62° 34′ 9″·59,
,, Sun = 219° 6′ 50″·17,
,, Moon = 332° 32′ 20″·47,

Now 169 days before Oct. 29, 518 A.D., the true longitudes were on May 13, at U.M.T. 6 hrs., for—

Jupiter = 53° 5′ 16″,
Sun = 52° 55′ 15″,

and these are practically equal. Hence according to Brahmagupta's rule Jupiter should rise heliacally 15·5 days later, *i.e.*, on May 29, 518 A.D. But on May 24, 518 A.D., the mean sun had, at G.M.N., the longitude of 63° 22′ 54″ and the mean moon at the same hour, the longitude of 50° 40′ 6″. Thus the new-moon came on the day following, the sun having a small positive equation. The new-moon-sun was in the *nakṣatra* division *Mṛgaśiras* (53° 23′ to 66° 40′ of longitude), and the Jovial year begun was *Mārga* or the *Mahā-mārga* year as the inscription says.

Thus the Gupta year, 199 = 518 A.D.
∴ Gupta year, **Zero** = 319 A.D.

XII. Twelfth Instance of Gupta Inscription Date *

Epigraphica Indica, Vol. 21, Plate No. 67—The Navagram Grant of Mahārāja Hastin

नमो महादेवाय। स्वस्ति अष्टनवोत्तरेऽब्दशते गुप्तनृपराज्यभुक्तौ श्रीमति प्रवर्द्धमाने महा-आश्वयुजसम्बत्सरे।

The year 198 of the Gupta era or 517 A.D., is called *Mahā-āśvayuja* year. We find that on April 7, 517 A.D., at U.M.T. 6 hrs.,

Mean Sun = 16° 51′ 25″·67,
,, Moon = 15° 55′ 0″·42,
Lunar Perigee = 230° 1′ 30″·70,
A. Node = 2° 58′ 20″·27,
Mean Jupiter = 14° 58′ 46″·35.

[1] Kielhorn's approximate date was 518 A.D., Oct. 15 or September 15—*Epigraphica Indica*, Vol. VIII, page 290.

* Communicated by Prof. D. R. Bhandarkar.

This was the day of the new-moon with Jupiter at the position very near to conjunction and consequently of heliacal setting. The new-moon happened in the *nakṣatra Bharaṇī*. Hence the year is called the *Mahā-āśvayuja* year.

Here also the Gupta year, **Zero**=319 A.D.

Conclusion

We have here proved, from 12 or 11 concrete statements found in the inscriptions, which have used either the Gupta or the Valabhī era, that—

(1) The Gupta and Valabhī eras were but one and the same era.

(2) It was most probable that the era in question had been originally started by the Gupta emperors and was given new name by the Valabhī princes who were vassals of the Gupta emperors.[1]

(3) The date from which the Gupta era was started was Dec. 20, 318 A.D., when began the **Zero year** of the era from the day of the winter solstice.

(4) That the Gupta era agrees with the Christian era from 319 A.D. till about 499 A.D., the date of Āryabhaṭa I, up to which the year reckoning began from the light half of *Pauṣa*.

(5) From some year which was different for different localities after 499 A.D., the beginning of the year was shifted forward from the light half *Pauṣa* or the Winter Solstice day to the light half of *Caitra*, conformably to Āryabhaṭa I's dictum of beginning the year from the Vernal Equinox day. This produced, in Indian calendars, "a year of confusion," as it is called in calendar reform. One year of the Gupta era and 420 of the Śaka era were thus reckoned as consisting of 15 or 16 lunations. This is evident from the inscriptions dealt with as Nos. V, VIII, X and XI. This change has been noticed in the inscriptions of those localities where Āryabhaṭa I's reputation as the foremost Indian astronomer had been unquestionably accepted. In such cases the Gupta years correspond more

[1] Fleet—Gupta Inscriptions, Plate No. 18, the Mandasor Stone Inscription of Kumāragupta and Bandhuvarman discussed in Chapter XXIV on the *Saṁvat* era.

conformably to the *Caitra-Śuklādi* Śaka years and that the Zero year of the Gupta emperors is taken as the Śaka year 241 (*Caitra-Śuklādi*) which is the same as the Christian year 319-20 A.D.

To sum up: The Zero year of the Gupta era was originally the same as the year 319 A.D., and in times later than 499 A.D. this Zero year was in some cases taken as equivalent to 319-20 A.D. Further the Gupta and Valabhī eras were the same era. It is hoped that further speculations as to this era would be considered inadmissible.

CHAPTER XXVI

TIME-INDICATIONS IN KĀLIDĀSA

As to the date of Kālidāsa, the greatest of our Sanskrit poets, most divergent views have been held by different researchers. According to Maxmüller, Fergusson and H. P. Śāstrī, Kālidāsa lived about the middle of the sixth century A.D. On the other hand, Macdonell, Vincent Smith and A. B. Keith have held that the poet flourished about the time of the Gupta Emperor Chandragupta, II, the first Indian monarch who, on epigraphic evidence, is known to have assumed the title of Vikramāditya (*ca.* 380-415 A.D.) This is of course on the assumption that Kālidāsa adorned the court of a king named Vikramāditya of Ujjayinī, a tradition which appears to be of very doubtful value. Then again Prof. S. Ray,[1] Sten Konow, Chatterjee and other Sanskritists of the old school have identified the now known Vikrama Saṁvat, with the era alleged to have been started by Vikramāditya of Ujjyainī and have tried to assign to the poet the first century B.C. But epigraphic and other evidences are, so far as I am aware, against this identification, as the original name of this Saṁvat era was 'Mālavābda' or even Kṛta era. We do not yet know when the original name of the era was changed into Saṁvat era.

As no definite epigraphic evidence about the date of Kālidāsa is forthcoming, such differences of opinion are quite natural, and any attempt to throw fresh light on the problem from a new point of view will probably be welcomed by scholars.

In this chapter we have tried to show that the great poet was thoroughly conversant with the Hindu *Siddhāntic* (scientific) astronomical literature, such references being found scattered throughout his poetical and dramatical works. These references have not been, as we shall see, correctly interpreted by his many

[1] Prof. S. Ray's paper, 'Age of Kālidāsa,' *J.R.A.S., Bengal,* 1908. Compare also the Allahabad University Studies, Vol. 2, 1926, "On the Date of Kālidāsa" by Chatterjee.

commentators including Mallinātha. The reason is obvious. These commentators were primarily rhetoricians and not experts in astronomy; hence they failed to get at the proper meaning of the passages and thus by their failure in this respect, have only 'darkened counsel by their words' in their commentaries. We take these references one by one; we shall try to interpret them correctly and ascertain their chronological significance.

(a) The first reference is—

Nakṣatra-tārāgraha-saṁkulā-pi jyotiṣmatī candramasaiva rātriḥ
—Raghu, VI, 22.

Here the word '*tārāgraha*' is a Hindu astronomical term not recognised by Mallinātha. It means 'star-like planets,' *viz.*, Mercury, Venus, Mars, Jupiter and Saturn in contradistinction to the Sun and the Moon which possess discs; the Hindu scientific astronomers throughout maintain this classification (cf. *Pañca-siddhāntikā*, XVIII, 61; the *Āryabhaṭīya*, *Gola*, 48; Modern *Sūrya Siddhānta*, VII, 1, etc.). Here Mallinātha splits up the compound word as 'nakṣatra'+'tārā'+'graha'. This sort of interpretation is apparently against the meaning of the poet.

(b) That Kālidāsa was a keen observer of the first visibility of crescent is evidenced by—

(i) Netraiḥ papus tṛptimanāpnuvadbhir
Navodayaṁ nāthamivauṣadhīnām —Raghu, II, 73.

(ii) Nidarśayāmāsa viśeṣadṛśyam
induṁ navotthānamivendumatyai —Raghu, VI, 31.

In these instances we have the expressions which are equivalent to 'the newly risen lord of the *oṣadhis*' and 'to newly risen moon'.

(c) We have further in Kālidāsa—

*Tisra*stri-lokīprathitena sārdhamajena marge *vasatī*ruṣitvā
Tasmādapāvartata Kuṇḍineśaḥ parvātyaye soma ivoṣṇaraśmeḥ'
—Raghu, VII, 33.

Here the poet says that in Aja's return journey to the city of Ayodhyā, the prince of Vidarbha (his brother-in-law), unwilling to part company of him as it were, accompanied Aja for *three nights*, just as the moon, as if unwilling to part company of the

sun at the conjunction, remains invisible for the maximum period of three nights and then separates from him. This interpretation makes the figure a *pūrṇopamā* or a complete similitude. Hence Kālidāsa was also an observer of the fact that the moon's maximum period of invisibility lasts for three nights. Mallinātha here fails to interpret the simile in Kālidāsa.

(*d*) Again we have the line—

Eṣa cārumukhi, yogatārayā yujyate taralavimbayā Śaśī

—Kumāra, VIII, 73.

'This Moon, O lovely one, is getting conjoined with the *liquid bodied*, "junction-star" of this night.'

Here we have the two words '*yogatārā*' and '*taralavimbayā*'; the first one means any one of the several 'stars' with which the moon gets conjoined in her 'sailing' through the sky in the course of a sidereal month. Mallinātha makes a muddle of the whole thing when he says that the moon is always accompanied by a particular star in all nights (*pratyahaṁyayā yujyate sā yogatārā*). Again the word '*tarala-vimbayā*' means liquid-bodied, and not as Mallinātha expounds it. A verse of the *Sūrya Siddhānta*, as quoted by Bhaṭṭotpala (966 A.D.) in the commentary on the *Bṛhatsaṁhitā* of Varāhamihira, runs thus :—

Tejasāṁ golakaḥ sūryo grahārkṣānyambugolakāḥ

Prabhāvanto hi dṛśyante sūryaraśmividīpitāḥ

—Bṛhatsaṁhitā, IV.

(first cited by Dīkṣita, in his work *Bhāratīya Jyotiḥśāstra*, p. 179).

'The sun is a sphere of energy, the planets and stars are spheres of *water*, they are seen shining by being illumined by the rays of the sun.'

This evidence shows that the poet had studied the *Sūrya Siddhānta* as known to Bhaṭṭotpala, and used the word '*tārala-vimbayā*' in the strict *Siddhāntic* sense.

(*e*) Another very important astronomical passage in Kālidāsa is—

Agastyacihnādayanāt samīpaṁ diguttarā bhāsvati sannivṛtte

Ānandaśītāmivavāṣpavṛṣṭiṁ himaśrutiṁ haimavatīṁ sasarja

—Raghu, XVI, 44.

or, 'when the sun neared the solstice (summer solstice) which was the place of *Canopus*, North caused a flow of ice from the Himālayas, which was like a delightfully cold shower of rain.'

Here also Mallinātha, owing to ignorance of *Siddhāntic* astronomy, fails to interpret the phrase '*Agastya cihna*,' which cannot but mean the ecliptic place of *Canopus*. His meaning of the phrase is 'the southern solstice' (the winter solstice). The poet in the very preceding stanza speaks of the advent of summer at the beginning of which the sun had already left the winter solstice *four months* before, and was only 60° distant from the summer solstice. The phrase in question undoubtedly means the summer solstice. As to the *Agastya's* (*Canopus*) 'polar' longitude and latitude the astronomical *siddhāntas* say :—

In Modern *Sūrya Siddhānta* (VIII, 10) we have 'Agastyo Mithunāntagaḥ'.

In *Pañcasiddhāntikā* (XIV, 10) we have 'Karkaṭādyāt'.

From the above and other works we learn of *Canopus's* place as

	Polar longitude	Polar latitude
Modern *Sūrya Siddhānta* ...	90°	S 80°
Pañcasiddhāntikā (550 A.D.) ...	90°	S 75° 20′
Brahmagupta (628 A.D.) ...	87°	S 77°
Lalla (748 A.D.) ...	87°	S 80°

From the above 'polar' longitudes of *Canopus* it appears that both Varāha and Kālidāsa belonged to the same school of *Siddhāntic* teaching. The date of the earliest form of the Modern *Sūrya Siddhānta* is most uncertain. It may even be about 560 A.D. as estimated by Burgess.[1]

(*f*) The poet is almost enamoured of the event of the sun's reaching the summer solstice when the tropical month of *Nabhas*, the first of the rainy season, began. The poet says in *Raghu*, XVIII, 6:—

> Nabhaścarairgītayjaśāḥ sa lebhe
> nabhastalaśyāmatanuṁ tanūjam ;
> Khyātaṁ nabhaḥśabdamayena nāmnā
> kāntaṁ nabhomāsamiva prajānām.

[1] If it was recast first into the modern form by Lāṭadeva (427 Saka year or 505 A.D.) as recorded by Alberuni (*India*, Vol. I, XIV, p. 1), the date may go up to, say, about 510 A.D. and not earlier.

'The king (Nala), whose fame was sung by the denizens of the sky, got a son of the same colour as the sky who became known by the name of *Nabhas* and was to his people, as pleasing as the month of *Nabhas*, the first of the rainy season.

(*g*) Kālidāsa has again in *Raghu*, XI, 36—

> Tau videhanagarīnivāsināṁ gāṁ gatāviva divaḥ punarvasū
> Manyate-sma pivatāṁ vilocanaiḥ pakṣmapātamapi
> vañcanāṁ manaḥ.

'The princes, Rāma and Lakṣmaṇa, as they stood before the people of the city of Videha, appeared as charming as the two stars *Castor* and *Pollux* of the *nakṣatra Punarvasu*. As they drank with their eyes the beautiful forms of the princes, their mind took it a disappointment that their tired eyelids fell preventing a continuous vision.'

To the poet why the stars *Castor* and *Pollux* were so charming, was that the sun reached the summer solstice at a place near to them, and the bursting of the monsoons took place. In the annual course, the star *Castor's* place is first reached by the sun. We shall not, therefore, be very wrong to assume that the poet indicates that the summer solstice of his time lay very near to the place of this star. The time when the summer solstitial colure passed through it was 546 A.D. It remains yet to be examined how far it indicates the date of the poet. Enough has been shown to establish, I trust, that Kālidāsa was well trained in the *Siddhāntic* astronomy of this time, was himself a keen observer of the heavens and specially of the moon's motion amongst the ecliptic stars. We now proceed to consider the other time-references in Kālidāsa's works.

Other Time-References in Kālidāsa

The first of these time-indications is derived from the *Meghadūta*. The stanzas in Part I, 1-4, say that the exiled Yakṣa addressed the cloud messenger on the first or last day of *Āṣāḍha*; '*prathama*' and '*praśama*' are the two variants of the text. In the edition of the *Meghadūta* by Hultzsch, the commentator Vallabhadeva accepts the reading *praśamadivase* and discards

the other, and Mallinātha on the other hand accepts the reading *prathamadivase* and rejects the other. We have to settle which is the correct reading. We learn from Part II, verse 49, that the Yakṣa's period of exile would end in four months more, when Viṣṇu would arise from his bed of the serpent Śeṣa ('Śāpānto me bhujagaśayanādutthite śārṅgapāṇau, śeṣānmāsān gamaya caturo, etc.'). The date for this last event being the day of the 11th *tithi* of lunar *Kārttika*, four lunations before it was the day of the 11th *tithi* of lunar *Āṣāḍha*. Hence the day on which the Yakṣa is said to have addressed the cloud messenger was that of the 11th *tithi* of lunar *Āṣāḍha*. As this day can never be the first or the last day of the lunar *Āṣāḍha*, and as this day can never fall on the first day of solar *Āṣāḍha*, the real reading of the text is '*Praśamadivase*' and not '*Prathamadivase*,' the month - being the solar, and never the lunar, *Āṣāḍha*. Thus the day on which the Yakṣa is made to address the cloud messenger was—

(1) The day of the 11th *tithi* of lunar *Āṣāḍha*.

(2) The last day of solar *Āṣāḍha*.

(3) The day of the summer solstice, as this was the day for the bursting of the summer monsoons marked by the first appearance of clouds. Here Kālidāsa says ' that a huge mass of the first-rain clouds hanging from the side of the hill looking like a fully developed elephant, burying its tusks on the hill side,' 'meghamāśliṣṭa-sānum vaprakrīḍā-pariṇata-gaja-prekṣaṇīyaṁ dadarśa,' as the poet has it. The next day itself was the first day of *Nabhas*, the first month of the rainy season. The poet says that this month was imminent or 'pratyāsanne Nabhasi' when the Yakṣa addressed the cloud. With the learned Sanskrit authors, the summer solstice day was the true day for the bursting of the monsoons. On this point *cf.* the *Rāmāyaṇa*, II, Ch. 63, St. 14-16.

The poet here in the *Meghadūta* has recorded a notable astronomical event of his time. We have already seen that he has indicated the position of the summer solstitial colure

as almost passing through the star *Castor*, that this time was about 546 A.D. Now examining the period from 541 to 571 A.D., we find that the day on which the three conditions tabled above were satisfied was :—

The 20th June, 541 A.D., on which, at G.M. Noon or the Ujjayinī mean time, 5—4 p.m.

		Khaṇḍakhādyaka	Moderns
True Moon	=	226° 1′	227° 2′
True Sun	=	89° 38′	90° 0′

Note.—The *Khaṇḍakhādyaka* is an astronomical compendium by Brahmagupta, dated 665 A.D., in which he sets forth the *ārdharātrika* system of astronomy as taught by Āryabhaṭa I. Varāha, in his *Sūryasiddhānta,* has borrowed wholesale from Āryabhaṭa I, but without mentioning in any way the source he is a borrower from.[1] There are indeed only two systems of the Hindu *Siddhāntic* astronomy, the *ārdharātrika* and the *audayika.* To the former class belongs also the Modern *Sūrya Siddhānta,* to the other class fall the *Āryabhaṭīya,* the *Brāhmasphuṭa-siddhānta* of Brahmagupta (628 A.D.), the *Śiṣyadhīvṛddhida* of Lalla (748 A.D.), the *Siddhāntaśekhara* of Śrīpati and the *Siddhāntaśiromaṇi* of Bhāskara I.

Here, according to the *Khaṇḍakhādyaka*, Moon—Sun=136°23′; the eleventh *tithi* was over about nine hours before, *i.e.*, at about 8 a.m. in the morning, and the first day of *Nabhas* was the next day, and that this date of June 20, 541 A.D., was the true last day of the solar *Āṣāḍha.* The sun's longitude according to the modern constants shows the day as the true day of the summer solstice of the year. This reference thus indicates the time of Kālidāsa as about 541 A.D., which is not very different from 546 A.D.. obtained before.

The second of these time-indications is derived from our poet's drama, *Abhijñānaśakuntala*, VII, 91. Here Kālidāsa employs

[1] P. C Sengupta, Translation of the *Khaṇḍakhādyaka*, the introduction, Calcutta University Press, 1934 A.D.

an astronomical simile to describe the final union of Duṣyanta with Śakuntalā. The prince thus speaks to his consort :—

Priye, Smṛtibbinnamohatamaso
Diṣṭyā pramukhe sthitāsi sumukhi
Uparāgānte śaśinā
Samupagatā Rohiṇī yogam.

'It is by a piece of good luck, my lovely darling, that you stand before me whose gloom of delusion has been broken by a return of memory. This has been, as it were, the star *Rohiṇī* has got conjoined with the moon at the end of a total eclipse.'

So far as we can see, our poet again uses another specially noticeable astronomical event of his time for a simile. A total eclipse of the moon happened according to Oppolzer's *Cannon der Finsternesse* on November 8, 542 A.D., with the middle of the eclipse at 17 hours 5 minutes of G.M.T. or the Ujjayinī mean time 22 hours 9 minutes: the half durations for the whole eclipse and the totality were 112 minutes and 51 minutes respectively. As to the magnitude and the half durations, I trust, Oppolzer's book is correct, although not based on the most up-to-date astronomical constants. The authorities for his longitudes were Leverrier and Hansen ; thus the beginnings and ends are not very correct as set forth below :—

On November 8, 542 A.D., at 17 hours 5 minutes, G.M.T., we have—

	Newcomb and Brown	Leverrier and Hansen
Apparent Sun ...	228° 28′ 49″	228° 28′ 46″
Apparent Moon [1] ...	48° 16′ 41″ [1]	48° 26′ 3″ [1]

Thus according to the most up-to-date authorities, Moon ~ Sun = 12′ 8″, while according to Oppolzer's authorities the same = 2′ 43″. The difference of 9′ 25″ would be gained by the moon in 19 minutes more. Consequently the beginnings, the middle and the ends have to be shifted forward by 19 minutes. *The eclipse thus began most conveniently at 8-36 p.m. and ended at 0 hour 20 minutes a.m. of the Ujjayinī mean time on November 9, at a very favourable time for the observation*

[1] Corrected by 12 principal equations.

of the conjunction of the moon with the star Rohiṇī (Aldebaran), and at this instant—

Apparent moon	... ...	49° 31′ 10″
Longitude of *Rohiṇī* (*Aldebaran*)	... ...	49° 30′ 11″
Latitude of *Rohiṇī* (*Aldebaran*)	... ...	−5° 28′ 17″

The moon at the end of the eclipse had almost complete equality in longitude with the star *Aldebaran* or *Rohiṇī*, as could be estimated by producing the line of the moon's cusps formed at the eclipse some time before its end.

The date of this peculiar lunar eclipse, *viz.*, 8-9 Nov., 542 A.D. confirms the dates 546 A.D. and 541 A.D. as obtained before. The period in which Kālidāsa in all probability observed these three astronomical events, which he has recorded in his work in his own way, runs from 541 to 546 A.D. The events thus tend to place Kālidāsa in the middle of the sixth century A.D.

In the previous reference (from the *Meghadūta*) we have shown before, that in the phrase '*Āṣāḍhasya praśamadivase*,' the word '*Āṣāḍha*' is to be taken in the sense of the 'solar' and not of the 'lunar' month of *Āṣāḍha*.

This interpretation makes the date of the poet later than the date of the starting of the Hindu *Siddhāntic* astronomy. I have not as yet come across any mention of solar months in Indian epigraphy. That the Hindu *siddhāntas* date from that epoch at which the planetary mean places (or even apparent places) are almost all equal to the tropical mean longitudes as calculated from the most modern astronomical constants, **is the sole test** by which it can be ascertained. Āryabhaṭa I indeed makes his epoch 3,600 years after the Kali epoch of 3102 B.C., Feb. 17, 24 hours or February 18, 6 hours of Ujjayinī mean time. The date and hour we arrive at is—

March 21, 499 A.D., Ujjayinī mean midday. The mean longitudes are shown in the following table[1] :—

[1] Compare also the Table on page 38.

Planet (1)	Ārdha-rātrika system (2)	Audayika system (3)	Mod. S, Siddhānta (4)[2]	Mean Trop. longitudes. Moderns (5)	Error in Ārdha-rātrika (6)	Errors in Audayika (7)
Sun ...	0° 0′ 0″	0° 0′ 0″	0° 0′ 0″	359° 42′ 5″	+17′ 55″	+17′ 55″
Moon ...	280° 48′ 0″	280° 48′ 8″	280° 48′ 0″	280° 24′ 52″	+23′ 8″	+23′ 8″
L.A. Node	352° 12′ 0″	352° 12′ 0″	348° 20′ 0″	352° 2′ 26″	+9′ 34″	9′ 14″
L. Apogee	35° 42′ 0″	35° 42′ 0″	34° 56′ 43″	35° 24′ 38″	+17′ 22″	+17′ 22″
Mercury	180° 0′ 0″	186° 0′ 0″	198° 7′ 48″	138° 9′ 51″	−189′ 51″	+170′ 9″
Venus ...	356° 24′ 0″	356° 24′ 0″	352° 48′ 0″	356° 7′ 51″	+16′ 9″	+16′ 9″
Mars ...	7° 12′ 0″	7° 12′ 0″	9° 48′ 0″	6° 52′ 45″	+12′ 15″	+19′ 15″
Jupiter ...	186° 0′ 0″	187° 12′ 0″	186° 0′ 3″	187° 10′ 46″	−10′ 47″	+1′ 12″
Saturn ...	49° 12′ 0″	49° 12′ 0″	50° 24′ 0″	48° 21′ 13″	−50′ 47″	+50′ 47″

The mean 'planets' of the *ārdharātrika* system are the same as taught by Varāha in his so-called *Sūryasiddhānta*. The date of the Modern *Sūrya Siddhānta* as judged by a similar test is put at 1091 A.D. by Bentley, which cannot be set aside as unacceptable (Calcutta University reprint of Burgess's translation, page 24). The reader may on this point compare Dīkṣita's work, the *Bhāratīya Jyotiḥśāstra*, page 200, 1st edn., and also my article, 'Hindu Astronomy' in the journal *Science and Culture* for June, 1944.

The planetary position as in cols. (2), (3) and (5) are in general agreement, excepting in that of Mercury, where the error is respectively −3° and +3° nearly in the above two systems. The next great difference of +51′ occurs in the mean place of Saturn ; in almost all other cases the Hindu mean places (or more correctly Āryabhaṭa's) are almost the same as calculated from the most modern constants. Hence there should not be any doubt as to the date from which the *Siddhāntic* calculations were started—that date must be March 21, 499 A.D. The Hindu rule for calculating what is called *Ayanāṁśa*, or the

[2] The Modern *Sūrya Siddhānta* longitudes are for 12 hours 33·6 minutes of U. M. Time.

distance of the 1st point of the Hindu sphere from the vernal equinox of date, also accept this as the date when the two points were coincident. There is another date also, *viz.*, 444 of Saka era or 522 A.D., called the Bhata year, from which also the *Ayanāmśa* is calculated. Thus we conclude that as Kālidāsa means the solar month of *Āṣāḍha* in the phrase '*Āṣāḍhasya praśamadivase*,' his date cannot be earlier than 499 A.D., or even 522 A.D. It was from about these dates that the Hindu signs of the zodiac were formed and solar months for the different signs of the zodiac came to be calculated in the Hindu calendar, in the form of transits of the sun from one sign of the zodiac to the next.

As to the date of Kālidāsa, we have, as set forth above, the first time-indication in which he hints that the summer solstitial colure of his time passed almost straight through the star *Castor*, for which the date has been worked out as 546 A.D. Secondly, the astronomical event of the combination of the last day of solar *Āṣāḍha*, the day of the 11th *tithi* of lunar *Āṣāḍha* and the day of the summer solstice falling on the same day has given us the date 541 A.D., June 20 Thirdly, the date of the total lunar eclipse, which was most favourable for the observation of the moon, being conjoined with the star *Rohiṇi* (*Aldebaran*) at its end, has led to the date Nov. 8—9, 542 A.D., so closely converging to the preceding dates. All these findings finally fix the date of the greatest of the Sanskrit poets at about the middle of the sixth century A.D. We have also shown that as the date of all the extant Hindu scientific *siddhāntas* cannot be earlier than 499 A.D., March 21, and that it may even be later than 522 A.D., the date of Kālidāsa cannot but be about 541-546 A.D., as he uses the phrase '*Āṣāḍhasya praśamadivase*,' which cannot but mean the last date of the solar month of *Āṣāḍha*. Even by the learned ancients such an expression, indicating the use of a solar month, was not possible before the time of Āryabhaṭa I, so far as I have come to learn from my study of Hindu astronomy for more than three decades. Before 499 A.D. this science was in the *amorphous state*. The Jyotiṣa Vedāṅga calendar has a tradition

that the five-yearly Vedic calendar was started from about 1400 B.C., but we have evidence to show that this calculation was never extended beyond five years. The late Mr. S Bn Dīkṣita, in his *Bhāratīya Jyotiḥśāstra*, page 125, has quoted a verse from the *Mahābhārata*, *Śānti*, Ch. 301, 46-47, in which we find that the calendar-makers or the wise men found 'omitted years, months, half lunations and even days' in trying to follow the five-yearly luni-solar cycle. It is a pity that nothing is on record to show when arose occasions for such adjustments being made and how these wise men failed to find the 19 years or the 141 years as the more correct luni-solar cycles by these processes. In these calculations there was no use of the signs of the zodiac and of no other planets except the sun and the moon. When Kālidāsa uses the solar month, we have an indication of the existence of *crystalline state* of Hindu astronomy

Date.	Ujjainī Mean Time hr.	Tropical longitude of the sun Moderns	The same referred to the M.V. Equinox of March 21, 499 A.D.	Khaṇḍa-khādyaka.[1] True Sun	Khaṇḍa-khādyaka. True Moon	Current tithi	Summer Solstice on
188 A D., June 23	6 a.m.	89° 50′ 38″	3ˢ 4° 9′ 7″	3ˢ 5° 12′46″	...	...	The 6th of solar Śrāvaṇa.
302 A.D., June 22	,,	89° 49′ 10″	3ˢ 2°27′52″	3ˢ 3° 33′ 18″	...	...	The 4th of solar Śrāvaṇa.
416 A.D., June 21	,,	89° 44′ 42″	3ˢ 0° 53′34″	3ˢ 1° 26′26″	...	...	The 2nd of solar Śrāvaṇa.
427 A.D June 21	,,	89° 6′ 41″	3ˢ 0° 6′ 24″	3ˢ 0° 37′19″	7ˢ 11° 14′32″	11th	The 2nd of solar Śrāvaṇa.
481 A.D., June 20	24 hrs.	90° 2′ 0″	3ˢ 0° 14′ 13″	3ˢ 0° 37′23″	7ˢ 11° 43′58″	11th	The last day of solar Āṣāḍha.

[1] We have followed the *Khaṇḍakhādyaka* of Brahmagupta in the calculations as no better or more reliable ancient works are known to us.

of the time of Āryabhaṭa I, which dates from March 21, 499 A.D.

For finally settling this point, there should be forthcoming epigraphic evidence as to the use of the solar months by the learned Indians before the time of Āryabhaṭa I. So far as I have seen, I have not come across any earlier use of solar months in any epigraphic statements: the dates are invariably stated in terms of the lunar months alone. If we want to explore the possibilities of a repetition of the *Meghadūta* astronomical event in the period from 188 A.D.—541 A.D., we find that the only previous date for its occurrence was 484 A.D., as the above calculations will show:

We refer the tropical longitudes of the sun to the mean vernal equinox of March 21, 499 A.D., as this was the true date from which the Hindu *Siddhāntic* calculations are really started and the mean vernal equinox of the date is the true first point of the Hindu sphere.

It apears from the above calculations that the date 541 A.D., June 20, may be raised by the short interval of 57 years to the date 484 A.D., June 20, from a pure astronomical finding taken singly. There are, however, at present no good reasons even for this small shifting of the date already arrived at, as explained already. It becomes quite inadmissible on a consideration of our last reference in the same way.

In the list of total eclipses of the moon visible in India and happening near the star *Aldebaran* as given in Oppolzer's *Cannon der Finsternesse* during the period from 400 A.D. to 600 A.D., we have only the following:—

Date	Middle of Eclipse G M.T.	Half duration for whole eclipse	Half duration for totality
459 A.D., October 27 ...	14 hrs. 30 mins.	111 mins.	50 mins.
477 A.D., November 6 ...	23 hrs. 21 mins.	111 mins.	50 mins.
542 A.D., November 8 ...	17 hrs. 5 mins.	112 mins.	51 mins.

As to the eclipse of date October 27, 459 A.D., there cannot be any conjunction of the moon with the star *Rohiṇī* (*Aldebaran*)

at its end, as both the date and the hour are unfavourable. As regards the eclipse of November 6, 477 A.D., it would end, according to Oppolzer's *Canon*, in the next day at the Ujjayinī mean time 6 hours 16 minutes. But as his authority for the longitude of the moon was Hansen, the end of the eclipse would have to be shifted forward by 23 minutes Hence the end of the eclipse would be at 6 hours 39 minutes of the Ujjayinī mean time. The sunrise works out as 6 hours 27 minutes of U. M. time, *i.e.*, the eclipse did not end before the sunrise on the day in question. Kālidāsa could not possibly mean this eclipse in his simile in the *Śakuntalā*.

The peculiar lunar eclipse on 8—9 November, 542 A.D , and the sun's turning south on June 20, 541 A.D., taken together thus fixes the date of Kālidāsa about the middle of the sixth century A.D., and this leads to the conclusion that the great poet and the astronomer Varāha were contemporary. We have also pointed out already that Kālidāsa indicates that the summer solstitial colure of his time passed through the star *Castor* for which the date becomes 546 A.D.

As to Varāha's date, we know that he flourished about 550 A.D., as he mentions Āryabhaṭa I (499 A.D.) by name and is himself mentioned by Brahmagupta (628 A.D.). Āmarāja, the commentator of the *Khaṇḍakhādyaka* of Brahmagupta, says that Varāha died in 587 A.D. Hence the two of the 'nine gems' of the tradition may be contemporary, but that they all belonged to the court of the King Vikramāditya may be wholly wrong.

As far as I have been able to ascertain, the verse which records the tradition, *viz.* :—

> Dhanvantari-Kṣapaṇakāmarasiṁghaśaṁku-
> Vetālabhaṭṭa-Ghaṭakarpara-Kālidāsāḥ
> Khyāto Varāhamihiro nṛpateḥ sabhāyām
> Ratnāni vai Vararuci-r-nava Vikramasya,

occurs first of all in the last chapter of the astrological work named the *Jyotirvidābharaṇa* by another *Kālidāsa*, who was an

astrologer—whose date cannot but be about 1243 A D. from the following considerations:—

In this work in the last chapter the author says that the epoch of his work is placed at 3,068 years of *Kali* elapsed, *i.e.*, 34 B.C. This cannot be the date of the author, as it is only the date from which the calculations are started. His rule for finding the distance of the origin of the Hindu sphere from the vernal equinox shows that this was *zero* at 445 of the Śaka year elapsed, or 523 A.D. This also cannot be the date of this astrologer Kālidāsa. If we examine his rules for finding when the sun and the moon would have numerically equal declinations except near about conjunctions and oppositions, this yields the result that at the time of this astrologer, the distance of the origin of the Hindu sphere from the vernal equinox was about 12°. This makes his date about 1243 A.D. This was also the finding of the late MM. Sudhākara Dvivedī in his Sanskrt work named *Gaṇaka Taraṅgiṇī*, page 46. This author can never be the same person as the greatest Sanskrit poet bearing the same name. As to the last chapter of this astrological work Pandit Dvivedī has said:—

Ayamantimādhyāyo granthakṛtā jagad-vañcanayā svayaṁ viracito vā kenacid itihāsānabhijñena prakṣipta iti niḥsaṁśayam ayanāṁśānayana-krāntisāmyasādhanair granthasthair vibhāti.

'This last chapter is either written by the author himself in order to deceive the world or that it was interpolated by a person who was ignorant of history: a conclusion which follows as a necessary corollary to the rules given in the body of the work for finding the distance of the origin of the Hindu sphere from the vernal equinox of date, and for finding the numerical equality in declination of the sun and the moon excepting near about conjunctions and oppositions.'

Thus any statement of the Vikramāditya tradition, if found only in the last chapter of this astrological work, cannot be taken as correct. The King Vikramāditya may be a mere invention. The moot point here is to explore earlier and more reliable

authors before this tradition may be accepted as true. Some of the 'nine gems,' however, may have been contemporary.

Then again the hypothesis that the 'Vikrama' era of having been started from 57 or 58 B.C. is also of very questionable nature, as its original name was perhaps not 'Vikrama' era but 'Mālava' or 'Kṛta' era. The reader is here referred to Chapter XXIV, pages 242-43.

From the facts stated above we may take it that the old name of the era in question was the Vikrama era. The traditional king Vikramāditya of Ujjayinī is in all probability a mythical person. He cannot be identified with any of the Gupta emperors who assumed the title of *Vikramāditya.* The now-known Saṁvat era can also have nothing to do with the time of Kālidāsa.

As to the date of Kālidāsa, so far as we can reasonably deduce from the astronomical data in his works, it comes out as about 541-546 A.D., or about the middle of the sixth century A.D., and that he is a contemporary of Varāhamihira. So far as I have seen, the finding in this paper would not go against any epigraphic evidence as discovered up to date.

EPILOGUE

The book has come to its end but it is felt necessary to make some concluding remarks for its future critics in respect of certain points.

First of all, as to Section I treating of the Date of the Bhārata Battle, it may be put forward that the *Mahābhārata* is only a great poem and as such, data derived from it cannot form any basis for finding the Date of the Bhārata Battle. It may also be suggested that the *Purāṇas* should more properly be used for the purpose. In reply to this it may be said that (1) the necessary astronomical data can be found only from the *Mahābhārata* and from no other source. (2) In the *Garga Saṁhitā* (not yet published) there have been found more than one statement which say or indicate that the Bhārata Battle was fought at the junction of the *Kali* and *Dvāpara Yugas*. Bhaṭṭotpala has quoted in his commentary on the *Bṛhatsaṁhitā*, XIII, 3[1] a verse which runs thus:—

कलिद्वापरसन्धौ तु स्थितास्ते पितृदैवतम् ।
मुनयो धर्म्मनिरताः प्रजानां पालने रताः ॥

"At the junction of the *Kali* and *Dvāpara* ages, the seven *Ṛsis* were in the *nakṣatra Maghā* ; they, faithful to their austerities, were the protectors of the peoples."

Again in the *Garga Saṁhitā* it is also said [2] that the *Mahābhārata* heroes were living at the end of the *Dvāpara* age. This "junction" of *Kali* and *Dvāpara* has been shown in pp. 35-42, as at January 10, 2454 B.C. The year in this *Mahābhārata cum Purāṇa Kaliyuga* had the Winter Solstitial reckoning, in contradistinction to Āryabhaṭa's vernal equinoctial years. The date of the Bhārata Battle, as determined at 2449 B.C., is exactly one luni-solar cycle of five years later than the *Dvāpara-Kali junction* year of 2454 B.C. This is a corroboration

[1] *Loc cit.*, page 15.

[2] R. A. S. Bengal, Manuscript, I. D. 20 (Fort Will. Coll.), Folio 102, 2.

of our finding from the *Garga Saṁhitā*, which cannot be only a "poem" like the *Mahābhārata*.

The *Purāṇic* evidences as to the Date of the Bhārata Battle are all incomplete and faulty as shown in Chapter III.

The *Mahābhārata* and the *Purāṇas* belong to the same class of literature called *Jaya* or tales of victory. The following extracts from the *Mahābhārata* will bear this out :—

(*a*) उवाच स महातेजा ब्रह्माणं परमेष्ठिनम् ।
कृतं मयेदं भगवन् काव्यं परमपूजितम् ॥६१॥

* * * *

इतिहास-पुराणानामुन्मेषं निर्मितं च यत् ।
भूतं भव्यं भविष्यञ्च त्रिविधं कालसंज्ञितम् ॥६३॥

Ādi, 1, 61 & 63.

(*b*) इतिहासमिमं श्रुत्वा पुरुषोऽपि सुदारुण' ।
मुच्यते सर्व्वपापेभ्यो राहुणा चन्द्रमा यथा ।
जयो नामेतिहासोऽयं श्रोतव्यो विजिगीषुणा ॥२०॥

Ādi, 62, 20.

From the first extract we learn that the *Mahābhārata* contains the beginnings of the *Purāṇas* and *Itihāsas* (history). In the *Mahābhārata* we find that only the *Vāyu* and *Matsya Purāṇas* are mentioned by name. The second extract says positively that the *Mahābhārata* itself is a *Jaya* or a tale of victory, and it is the earliest of this class of literature. The *Purāṇas* are extremely faulty in their dynastic lists and the summarisers who state the interval between the birth of Parikṣit and the accession of Mahāpadma Nanda are hopelessly unreliable. The *Mahābhārata* as a basis for finding the Date of the Bhārata Battle has been shown as far superior to the *Purāṇas*.

Last of all, it may be urged that Bhīṣma as a hero in the great fight is an impossibility—that his lying on the bed of arrows for 58 nights before expiry in anticipation of the day following the winter solstice is a solar myth. The orthodox Indian view is ranged against this allegation. If we agree that this was a myth, we should not lose sight of the fact that the real necessity for creating it lay in correctly finding the begining of the **year One** of the Judhiṣṭhira era, of which zero year was the year of the

great battle. Hence even accepting the character of Bhīṣma in the fight as a solar myth, the Date of the Bhārata Battle as found remains valid. In ancient times the first day of the year was the day following the winter solstice. Even now Christ's birth-day is observed on the 25th December. In the first century B.C. the 24th December was the winter solstice day, and the 25th December, was the first day of the sun's northerly course, or the birth of Christ was synchronous with the birth of the year. In both cases the myths may also have been created round these great personages on the basis that a certain great astronomical event such as the beginning of the year coincided with their birth or death.

In Section II on Vedic Antiquity, the heliacal rising of different stars in different seasons has been used as a basis for the determination of time. In all these cases the depression of the sun below the horizon, at the time of the heliacal rising of stars, has been uniformly taken at 18°. In the case of the bright stars, *e.g., Sirius, Regulus*, etc., the sun's depression should have been taken less than this amount. In this connection we would say that we do not know how far accurate were the observers of those days of hoary antiquity as to the heliacal risings of stars. We do not also know how far the horizon was clear in different seasons at Kurukṣetra, the assumed centre of Vedic culture, for such observations and what was the necessary or accepted altitude of the star above the horizon in the several cases. In certain case we have admitted possible lowering of the date by a few centuries.

ग्रन्थोऽयं पूर्त्तिमापन्नो बह्वायाससमुद्भवः ।
प्रीत्यै भूयाद् भगवतोर्भवानीविश्वनाथयोः ॥
शोधनीयानि कृपया यान्यत्र स्खलनानि हि ।
विपश्चिद्भिः सहृदयैर्गुणदोषविचारकैः ॥
काल-निर्णयविद्यास्मिन् ज्योतिःशास्त्रानुसारिणी ।
अनन्यमनसा तावद् यतिता विदुषां दृशे ।
प्राज्ञे सेयं स्वयं यातु विस्तारं वस्तुशक्तितः ॥
माणिकगञ्जोपभागस्थ-त्रायराग्रामनिवासिना ।
धन्वन्तरिकुलोद्भूत-वामारामाङ्कलालित-
प्रबोधचन्द्र सेनेन कृतः कालविनिर्णयः ।

SOME OPINIONS ON THE RESEARCHES EMBODIED IN THE PRESENT WORK

A

(*Extract from "Nature," January 6, 1940, Vol. 145, No. 3662, p 38-39*)

"SOME INDIAN ORIC ... TE LIGHT OF ASTRO- NO ... CE

Among recent cor ... the Royal Asiatic Society of Bengal, several ... etails of a technical character in palaeographical an... orical studies bear upon points of interest and importance in the archaeological investigation of the origin and development of Indian civilization.[1]

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Conclusions of a more surprising character, based on astronomical evidence, have been formulated by P. C. Sengupta in a series of papers discussing chronological and other problems in early Indian history. The first of these deals with the date of the Bharata battle, the great conflict which forms the central incident of that great monument of early Indian literature, the Mahabharata. The date for this battle, as usually accounted is indicated by three lines of traditional evidence at 3102-3101 B.C. The author, on an examination of one of these traditions, the evidence of the Yudhishthira era, has shown that the astronomical references justify the inference

1 J. R Asiatic Soc., Bengal, Let ers 4, 3 (1938), issued September, 1939. Cf. Chapters II, III, XIII, IV and V of the present work.

that the great battle took place in 2449 B.C. He now turns to examine the remaining two traditions, the Aryabhata and the Puranic traditions.

The calculation depends upon the dating of the Kaliyuga, which the Mahabharata states had just begun and to which the date February, 3102 B.C. is assigned. It cannot, however. be reconciled with the astronomical Kaliyuga, and is shown to be based upon an astronomical calculation in which conditions are correct only for A.D. 499, when the Hindu scientific Siddhantas came into being. It depends upon an incorrect assumption of the position of the solstices of Pandava times and an incorrect annual rate of the precession of the equinoxes. A corrected back calculation from conditions in the heavens corresponding to those recorded in the Mahabharata, that is conditions in the period February 1924-35, gives a date January 10, 2454 B.C. as the beginning of this Kaliyuga era, and 2449 B.C. as the year of the battle.

This leads to futher inquiry as to observation of the solstices in successive ages. This was determined by the phases of the moon in the month of Magha, a lunar month of which the beginning at the present time may be from January 15 to February 11. In the calendar of the Vedic Hindus, this month started the five-year cycle which began "when the sun, the moon and the Dhanisthas (Delphinis) cross the heavens together ; it is the beginning of the Yuga, of the month of Magha or Tapas, of the light half and of the sun's northerly course." From the astronomical conjunctions to which reference is made in the Mahabharata, it would appear that this reckoning was started (traditionally by Brahma) at about 3050 B.C.

There are three peculiarities of this month :

(1) it began with a new-moon near Delphinis ; (2) the full-moon was near Regulus ; (3) the last quarter was conjoined with Antares. Such a month did not come every year, but it was the standard month of Magha. In our own times, it occurred in 1924 during February 5—March 5, a year which for the purpose of this investigation is taken as the gauge year.

References in the Brahmanic and other works directly state or indicate the winter solstice of successive Vedic periods. From these astronomical references fixing the position of the moon in relation to the winter solstice and the beginning of the month of Magha, a matter of ritual importance in connection with the year-long and other sacrifices, it has been possible to fix by calculation back from the corresponding conditions in recent years a series of dates beginning with 3550 B.C , the earliest date of the age of the Brahmanas, and covering a period of 1450 years with a possible error of 400 years. It was thus during this period that the Brahmanic literature developed.

Next is considered Madhu-vidyā or the science of Spring, which as here interpreted is really the knowledge of the celestial signal for the coming of spring, addressed to the Aśvins, who are identified with α and β Arietis, the prominent stars in the Aśvini cluster. The three stars, α, β and γ Arietis, form a constellation which is likened to the head of a horse. The Aśvins are spoken of in several passages of the Rigveda as riding in the heavens in their triangular, three-wheeled, and spring-bearing chariot.

From certain references it would seem that when the car of the Aśvins first becomes visible at dawn, spring began at some place in the latitude of Kuruksetra in the Punjab. The jealously guarded Madhu-vidya or " science of Spring " was thus nothing but knowledge of the celestial signal of the advent of Spring—the heliacal rising of α, β and γ Arietis.

By astronomical calculation it can be shown that this event at the latitude mentioned took place at, say 4000 B.C. Hence it is beyond question that the Vedic Hindus could find accurately the beginning of winter, spring and all seasons of the year.

The earliest epigraphic evidence of Vedic chronology from cuneiform inscriptions referring to Indra and other gods of the horse riding Kharri or Mitanni dates from about 1400 B.C. In the absence of further epigraphic evidence, it is pointed out, this definite finding of the astronomical evidence derived from the literature as to the antiquity and chronology of the Vedas must

be allowed to stand. It establishes, it is maintained, that the civilization of the Vedic Hindus was earlier than that of the Indus Valley as evidenced by the remains at Mahenjo-daro.

Finally, in "When Indra became Maghavan," Mr. Sengupta turns to the relation of the Vedic god Indra, the "shedder of rain" and "wielder of the thunderbolt," to the summer solstice. The references to this god in the Rigveda, when divested of all allegory, suggest that he is the god of the summer solstice, while the clouds as represented by a demon are unwilling to yield up their watery store until assailed by the thunderbolt hurled by the god.

The monsoons which bring the rains usually burst about June 22, and there is usually a drought which lasts for about a month before the monsoon comes. The demon Śuṣṇa (drought) is killed by Indra. The fight with Vritra or Ahi, the cloud demon, is thus an annual affair which takes place when the sun enters the summer solstice, Indra withdrawing his raingiving (or annual) bow with the coming of autumn.

When did Indra become the slayer of Vritra? The answer given by the Rigveda is when Indra by the rising of Maghas became Maghavan. Maghas to us must be the constellation Maghas consisting of α, η, γ, ζ, μ, and ϵ Leonis, at the heliacal rising of which the sun reached the summer solstice at the latitude of Kuruksetra (lat. 30 N.) This it is shown must have happened in 4170 B.C."

B

Sky and Telescope, Vol. I. No. 5., March, 1942.
Harvard College Observatory, Cambridge, Mass.
Page 10. News and Notes.

"ECLIPSE OF JULY 26, 3928 B.C.[1]

Astronomy has come to the aid of the historian in determining the time of the earliest known Aryan colonisation in India. According to P. C. Sengupta (Journal of the Royal Asiatic Society

[1] *Cf.* Chapter IX of the present work.

of Bengal for August, 1941), this began about 3900 B.C. A solar eclipse, described in the Rigveda, had been observed by Atri, one of the earliest settlers in the northern Punjab. From various historical and etymological considerations, Sengupta deduces that the eclipse occurred between the years 4000 and 2400 B.C. He then lists five other conditions that must be satisfied in the determination of the actual date.

It must have been a central eclipse, taking place on the day of the Summer Solstice or the following day. It must have ended during the fourth quarter of the day at meridian of Kuruksetra. It was observed from a cave at the foot of a snowcapped peak, either the Himalayas or the Karakoram range. Finally, at the place where Atri was, the eclipse did dot reach totality.

Among the 22 central solar eclipses that occurred near the Summer Solstice within the given time interval, there is one and only one that fulfils all of the required conditions inferred from the Rigveda. That one occurred on July 26, 3928 B.C. (Julian Calendar).

Sengupta's painstaking researches thus place the date of the first settlement of Aryans in India earlier than previous investigators believed. To most Americans, whose ancestry can be traced but a few hundred years, observations made at so early an epoch might appear to have a purely mythological value. It is a source of satisfaction to find that they conform with astronomically predictable facts."

ERRATA

Page	Line	For	Read
8	Footnote, l. 5	माथोऽयं	माघोऽदं
16	9	160×4	160×3
17	27	120° 28′ 36″	192° 28′ 36″
19	Footnote, l. 3	1938	1939
24	2	date	data
31	Table cols. 5 and 7	sagitter	sagttar
41	Footnote, l. 6	देशाखस्य	दैशाखस्य
45	,, l. 3	*Epigraphia*	*Epigraphica*
51	25	सनेय	सनये
64	Footnote, l. 4	ऊषक्य:	ऊषस:
71	,, l. 1	त्व	स्वा
71	,, l. 2	ब्रहस्पति	ब्रहस्पति:
81	28	at	of
84	12	as have	as to have
84	Footnote, l. 7	भागमतन	भागकैतन
85	,, l. 2	सभवो	सभवो
88	14	end	and
98	14	*Pcgasi*	*Pegasi*
112	17	930	93
125, 126	18 and 17	1934″ (M+S)	1964″=(M+S)
125, 127	19 and 18	41″ (M−S)	41′=(M−S)
145	Footnote, l. 2	कुष्ठ	कुष्टं
154	Sanskrit	सोमा	सामा
154	,,	स्वरसान	स्वरसाम
158	Footnote, l. 14	heir	their
172	27	*Solsticial*	*Solstitial*
204	Table, 6	−186	−885
210	8	T 756 A.D.	−756 A.D.
210	8	−0 hr.	T., 0 hr.
210	21	762 A.D.	−762 A.D.
211	13	906 A.D.	−906 A.D.
212	17	च्चिषादङ्गान्	दचिषाङ्गान

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